A SURVEY OF

AUTOMATIC DIGITAL COMPUTERS

1953

OFFICE OF NAVAL RESEARCH
DEPARTMENT OF THE NAVY
WASHINGTON, D. C.

A

SURVEY

OF

AUTOMATIC DIGITAL COMPUTERS

1953

Office of Naval Research
Washington, D.C.

PREFACE

A "Survey of Large-Scale Computers and Computer Projects," by Mr. A. E. Smith of the Office of Naval Research, was originally published in 1947 and 1948 and was brought up to date and republished in 1950. Since that time the computer art has developed rapidly, and a large number of machines that were then only in the design stage are now in successful operation. Early in 1953, Dr. N. M. Blachman of this Office undertook to gather all available information and publish a new "Survey." In this laborious undertaking he received much valuable assistance from Messrs. J. B. Kruskal, Jr., and J. J. Wolf of the Logistics Research Project at George Washington University, and from LTJG D. L. Hogan, USNR, during a two weeks' tour of training duty at ONR, as well as from LT R. R. Weber, USNR, of the London Branch Office of ONR. The cooperation of the Computation Research Team, Flight Research Laboratory, Wright-Patterson Air Force Base, in making available information that had been gathered for the preparation of a similar survey is gratefully acknowledged.

C. B. Hart

C. B. Hart, CAPT, USN
Assistant Chief for Research

CONTENTS

CONTENTS (Cont'd)

CONTENTS (Cont'd)

INTRODUCTION

On the following pages are presented data on nearly one hundred automatic digital computers intended for more or less general-purpose computation. This information was obtained, for the most part, during the month of February 1953, by means of questionnaires. This compendium was made possible by the very nearly 100 percent response to those questionnaires. While this Survey is as accurate and complete as it could be made under the circumstances, it should be recognized that the data presented are subject to change in as rapidly expanding a field as that of digital computers. Unfortunately, a few machines are omitted for want of information on them.

Most of the entries on the following pages are self-explanatory, but a few words are in order concerning others. The date when "first ready for use" must be interpreted in the light of the February 1953, date of collection of the information. In the case of commercially available computers, this date often refers to use at the customer's location; in other cases it refers to the first useful operation of the computer by the builder. The "floor area" refers in some cases to the entire room housing the computer, and in other cases to the base area of the arithmetic, storage, and control circuitry. The unit "ton" for cooling refers to the amount of cooling provided by the melting of one ton of ice per day at 32^{0} F.

Storage is designated "internal" only when an instruction address refers to a single stored word, and in some cases arithmetic registers have been included under internal storage. Tapes which cannot be both written on and read from under the control of the computer are listed under "input/output" media. In other cases the nomenclature has not been standardized; "match," "normalize," and "justify," for example, all refer to the operation of shifting a number left until its most significant digit is non-zero, and counting the number of places shifted. "Logical multiplication" and "logical 'and'" likewise are synonymous.

At the end of the tabulation are three indexes: (1) listing the computers by name, (2) listing the builders, and (3) giving the geographic location of both the builders and the computers. All left-hand pages have been left blank in order to permit the reader to insert additional data which he may acquire.

ABC
(Automatic Binary Computer)

BUILT BY: Air Force Cambridge Research Center, Cambridge, Massachusetts
INSTALLATIONS: Air Force Cambridge Research Center
(Financial contributions made by Air Research Development Command and the U. S. Air Force.)

COPIES AVAILABLE: No
PROGRAMMING SERVICE: Not available.
COMPUTING TIME: Not available.
FLOOR AREA: 250 sq. ft. POWER CONSUMPTION: 7½ kw.
COOLING: 1100 cu.ft. min. FIRST READY FOR USE: May 1953.
BEST SUITED FOR: Complex operations on relatively few numbers.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2 (8 or 10 externally).
WORD LENGTH: 56 binary digits.
NUMBER RANGE: INSTRUCTION TYPE: Four-address.
NEGATIVE NO. REP.: Ones' complement. SEQUENCE CONTROL: General store.
OPERATIONS: Add, subtract, multiply, divide, convert, conditional transfer, "and", "or", count ones, order of magnitude.

SPEED:

		Transfer	Addition	Multiplication	Division	Other		
Incl. Access	Min.	1.5 ms						
	Max.	50 ms						
Excl. of Access		1.5 ms	20 μs	1.2 ms	1.2 ms	1.2 ms	or less	

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic Drum	Internal	4096	128	50 ms	1.5 ms	Serial	20" dia. x 36" long	1200 rpm

INPUT/OUTPUT:

Type	Function	Speed
Flexowriter	In-Out	

TAPE SEARCH:
ARITHMETIC MODE: Parallel. CLOCK FREQ.: Arithmetic unit 100 kc; drum 40 kc.
COMPUTING ELEMENT: Flip-flop.
COMPONENTS: 1200 tubes, 500 crystals, 50 relays.
REMARKS: Overflow and order sensing checks are built in. The binary point location is variable.

ACE Pilot Model
(Automatic Computing Engine)

BUILT BY: Electronics Section, National Physical Laboratory
INSTALLATIONS: National Physical Laboratory, Teddington, England

COPIES AVAILABLE:
PROGRAMMING SERVICE: Available.
COMPUTING TIME: Available.
FLOOR AREA: 152 sq. ft. POWER CONSUMPTION:
COOLING: FIRST READY FOR USE:
BEST SUITED FOR:

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2
WORD LENGTH: 32 binary digits
NUMBER RANGE: INSTRUCTION TYPE: Two-address
NEGATIVE NO. REP.: SEQUENCE CONTROL: General storage
OPERATIONS:

SPEED:		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.			2 ms				
	Max.			2 ms				
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Mercury delay line	Internal	360	18	1024 μs	32 μs	Serial	Most lines 32 words long, some lines 1 word long.	

INPUT/OUTPUT:

Type	Function	Speed
(Hollerith) punched cards	Input	4 words/sec
(Hollerith) punched cards	Output	
Typewriter	Output	
(Hollerith) gang printer	Output	3 80-character lines/sec

TAPE SEARCH:
ARITHMETIC MODE: Serial CLOCK FREQ.: 1 megacycle
COMPUTING ELEMENT:
COMPONENTS: About 800 tubes.
REMARKS:

ALWAC
(Axel Wenner-Gren Automatic Computer)

BUILT BY: Logistics Research, Inc., Redondo Beach, California
INSTALLATIONS: ALWEG Corp., Cologne, Germany
David Taylor Model Basin, Carderock, Maryland

COPIES AVAILABLE: For sale.
PROGRAMMING SERVICE:
COMPUTING TIME:
FLOOR AREA: 28" x 116". POWER CONSUMPTION: 4 kw.
COOLING: Internal fans. FIRST READY FOR USE: December 1953.
BEST SUITED FOR: General purpose; monorail calculations, wind-tunnel data reduction.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING				
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair	Idle	Total
Hrs/Wk							
Percent							

PERSONNEL: Routine maintenance is provided by the manufacturer for one year.

NUMBER BASE: 2
WORD LENGTH: 32 binary digits, sign, and 2 check digits.
NUMBER RANGE: INSTRUCTION TYPE: "No address," 4 orders/word.
NEGATIVE NO. REP.: Sign & abs. value. SEQUENCE CONTROL: Working storage.
OPERATIONS: Add, subtract, multiply, divide, transfer, absolute value, extract, negate, compare, overflow, shift, count down, input, output, complement.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.		1 ms					
	Max.		8 ms					
Excl. of Access			1 ms	34 ms	34 ms			

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic drum	Internal	2048	64	50 ms		Serial		
	Working	64	2	8 ms	1 ms	Serial		
	Arith.	4		1 ms		Serial		

INPUT/OUTPUT:

Type	Function	Speed
Punched paper tape	In&Out	10 decimal digits/second
10 typewriters	In&Out	10 decimal digits/second

TAPE SEARCH: None.
ARITHMETIC MODE: Serial. CLOCK FREQ.: 67 kc.
COMPUTING ELEMENT:
COMPONENTS:
REMARKS: Of the 4 "syllables" in an instruction word, each may represent a command or an address for the preceding command if required. This address will refer to a syllable or word in either of 2 "working storage" channels or to an entire main storage channel. Part of the computer is a test box, which can statically or dynamically test any of the plug-in units.

APE(R)C
(All-Purpose Electronic (Rayon) Computer)

BUILT BY: Birkbeck College, University of London

INSTALLATIONS: British Rayon Research Association, Manchester
British Tabulating Machine Co. - HEC-1 and HEC-2 (Hollerith Electronic Computer)
(The Rockefeller Foundation, Imperial Chemical Industries, the British Rayon Research Association, and the British Tabulating Machine Co. contributed support to the development of the computer.)

COPIES AVAILABLE: For sale.

PROGRAMMING SERVICE: Available.

COMPUTING TIME: Available.

FLOOR AREA: 20 sq.ft. POWER CONSUMPTION: 2 kw.

COOLING: None. FIRST READY FOR USE: June 1952.

BEST SUITED FOR: General purpose; statistics.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk			37.2		2.8		40
Percent			93		7		100%

PERSONNEL: 1 mathematician, 1 clerical, 1 operator-mainterance man.

NUMBER BASE: 2 (8 or 10 externally).

WORD LENGTH: 32 binary digits.

NUMBER RANGE: -1 to 1. INSTRUCTION TYPE: Two-address.

NEGATIVE NO. REP.: Complement. SEQUENCE CONTROL: General store.

OPERATIONS: Addition, subtraction, multiplication.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	1.2 ms	1.2 ms	1.2 ms	Programmed			
	Max.	20 ms	20 ms	38.4 ms				
Excl. of Access		1.2 ms	1.2 ms					

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic drum	Internal	512	32	20 ms	1.2 ms	Serial	5"dia. 1"long	3000rpm

INPUT/OUTPUT:

Type	Function	Speed
Teletypewriter	In&Out	7 digits per second
Punched-card tabulator	In&Out	32x150 digits/minute

TAPE SEARCH: None.

ARITHMETIC MODE: Serial CLOCK FREQ.: 30 kc.

COMPUTING ELEMENT: Double triode.

COMPONENTS: 420 tubes, 30 relays.

REMARKS:

APE(X)C
(All-Purpose Electronic (X-Ray) Computer)

BUILT BY: Birkbeck College, University of London

INSTALLATIONS: Birkbeck College Electric Computation Laboratory (The Rockefeller Foundation, Imperial Chemical Industries, and the British Tabulating Machine Co. contributed support to the development of this computer.)

COPIES AVAILABLE:

PROGRAMMING SERVICE:

COMPUTING TIME:

FLOOR AREA: 20 sq. ft. POWER CONSUMPTION: 2 kw.

COOLING: None. FIRST READY FOR USE: End of 1953.

BEST SUITED FOR: General purpose.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2 (8 or 10 externally).

WORD LENGTH: 32 binary digits.

NUMBER RANGE: -1 to 1. INSTRUCTION TYPE: Two-address.

NEGATIVE NO. REP.: Complement. SEQUENCE CONTROL: General store.

OPERATIONS: Addition, subtraction, multiplication.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	0.6 ms	0.6 ms	0.6 ms	Programmed			
	Max.	20 ms	20 ms	19.2 ms				
Excl. of Access		0.6 ms	0.6 ms					

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic drum	Internal	1024	32	20 ms	0.6 ms	Serial	5" dia. 1" long	3000 rpm

INPUT/OUTPUT:

Type	Function	Speed
Teletypewriter	In&Out	7 digits per second
Punched-card tabulator	In&Out	32x150 digits per minute

TAPE SEARCH: None.

ARITHMETIC MODE: Serial. CLOCK FREQ.: 60 kc.

COMPUTING ELEMENT: Double triode.

COMPONENTS: 310 tubes, 3 relays.

REMARKS:

ARRA
(Automatische Relais Rekenmachine Amsterdam)

BUILT BY: Mathematisch Centrum, Amsterdam, the Netherlands
INSTALLATIONS: Mathematisch Centrum.

COPIES AVAILABLE: No.
PROGRAMMING SERVICE:
COMPUTING TIME:
FLOOR AREA: 80"x16" plus desk. POWER CONSUMPTION: 3 kw.
COOLING: None. FIRST READY FOR USE: 1954.
BEST SUITED FOR: General purpose.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2 (10 externally).
WORD LENGTH: 30 binary digits (instructions 15 binary digits).
NUMBER RANGE: -1 to 1. INSTRUCTION TYPE: One-address.
NEGATIVE NO. REP.: Ones' complement. SEQUENCE CONTROL: General store.
OPERATIONS: Addition, subtraction, multiplication, division, print, etc.

SPEED:		Transfer	Addition	Multiplication	Division	Shift	Mult. by 10	
Incl. Access	Min.	7.5 ms	7.5 ms	87.5 ms	87.5 ms	27.5 ms	27.5 ms	
	Max.	27.5 ms	27.5 ms	107.5 ms	107.5 ms	27.5 ms	27.5 ms	
Excl. of Access		2.5 ms	2.5 ms	82.5 ms	82.5 ms	5.0 ms	10.0 ms	

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic drum	Internal	1024	64	22½ ms	2½ ms	Serial	11cm.dia.	3000rpm
		30-bit wds					30 cm.long	

INPUT/OUTPUT:

Type	Function	Speed
Paper tape	Input	30 characters/sec.
Typewriter	Output	8 decimal digits/sec.

TAPE SEARCH:
ARITHMETIC MODE: Serial. CLOCK FREQ.:
COMPUTING ELEMENT: Selenium rectifiers.
COMPONENTS: 500 tubes, 2000 selenium rectifiers, and 15 relays.
REMARKS: This computer, though electronic, has been named after its relay predecessor.

AVIDAC
(Argonne's Version of the IAS Digital Automatic Computer)

BUILT BY: Argonne National Laboratory, Lemont, Illinois
INSTALLATIONS: Argonne National Laboratory

COPIES AVAILABLE: No.
PROGRAMMING SERVICE: No policy fixed.
COMPUTING TIME: No policy fixed.
FLOOR AREA: 500 sq. ft. POWER CONSUMPTION: 20 kw.
COOLING: 3500 cu.ft./min. FIRST READY FOR USE: In operation now.
BEST SUITED FOR: General scientific.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2 (16 externally).
WORD LENGTH: 40 binary digits (instructions 20 binary digits).
NUMBER RANGE: -1 to $1-2^{-39}$. INSTRUCTION TYPE: One-address
NEGATIVE NO. REP.: Twos' complement SEQUENCE CONTROL: General store.
OPERATIONS: Add, subtract, multiply, divide, several transfers of control, partial substitution into the memory.

SPEED:		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.		20 μs	500 μs	800 μs			
	Max.		40 μs	520 μs	820 μs			
Excl. of Access			20 μs	500 μs	800 μs			

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Electrostatic (Williams tube)	Internal	1024	40	20 μs	0 μs	Parallel	5CP1A	
Magnetic Tape	External	50,000	40	20 s	20 ms	Parallel	80' long	50"/sec.

INPUT/OUTPUT:

Type	Function	Speed
Teletype	In-Out	12 characters/sec.

TAPE SEARCH: Possible in both directions.
ARITHMETIC MODE: Parallel. CLOCK FREQ.:
COMPUTING ELEMENT:
COMPONENTS: 2800 tubes, no crystals, no relays.
REMARKS: The machine is currently in operation for porblem solving, using only 256 words in internal memory and no external memory, but is still being debugged (March 1953). A single external magnetic tape unit of preliminary design will probably be installed within 6 or 8 months, and the internal memory will probably be increased to capacity in that time. Later it is planned to install 4 tape units of greater capacity and perhaps higher speed. The logical design of this computer is modelled on the IAS computer.

BARK
(Binär Automatisk Relä-Kalkylator)

BUILT BY: Matematikmaskinnämndens Arbetsgrup

INSTALLATIONS: Matematikmaskinnämndens Arbetsgrup, Kunglig Tekniska Högskola, Stockholm, Sweden
(This group is supported by the Swedish Board for Computing Machinery and the Royal Telegraph Administration.)

COPIES AVAILABLE: No.

PROGRAMMING SERVICE: Available.

COMPUTING TIME: Available.

FLOOR AREA: 710 sq. ft. POWER CONSUMPTION: 5 kw.

COOLING: None. FIRST READY FOR USE: February 1950. tabulation.

BEST SUITED FOR: General purpose; integration of o.d.e., matrix inversion,/

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Plugging for Programs	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk	5		74			14	93
Percent	5		80			15	100

PERSONNEL: 4 operators, 3 mathematicians, 1 maintenance man, 1 clerical.

NUMBER BASE: 2(input is decimal, output is octal or decimal). & sign.

WORD LENGTH: 25 bits for numerical part & sign plus 7 bits for exponent/

NUMBER RANGE: 10^{-19} to 10^{19} INSTRUCTION TYPE: 3-address.

NEGATIVE NO. REP.: Absolute value&sign SEQUENCE CONTROL: Non-removable plugboard.

OPERATIONS: Several transfer and addition operations, multiplication, logical addition, shift, input, transfer exponent to numerical part of number, transfer 6 digits of numerical part to exponent, and output.

SPEED:

		Transfer	Addition	Multiplication	Division	Transfer	Reciprocal
Incl. Access	Min.						
	Max.	AVERAGE	200 ms	300 ms		100 ms	2 or 3 sec.
Excl. of Access							

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Relay registers	Internal	100				Parallel		

INPUT/OUTPUT:

Type	Function	Speed
2 binary punched tapes	In&Out	One word per second
5 decimal punched tapes	In&Out	8 digits per second
3 typewriters	Output	8 digits per second

TAPE SEARCH: None.

ARITHMETIC MODE: Parallel. CLOCK FREQ.:

COMPUTING ELEMENT: Relays.

COMPONENTS: About 7,500 relays.

REMARKS: See G. Kjellberg and G. Neovius, "The BARK, A Swedish General Purpose Relay Computer," Mathematical Tables and other Aids to Computation. V, No. 33, pp. 29-34 (Jan. 1951).

BUILT BY: Bell Telephone Laboratories, Murray Hill, New Jersey.
INSTALLATIONS: National Advisory Committee for Aeronautics, Langley Field, Va.
Ballistic Research Laboratories, Aberdeen Proving Ground, Md.

(Where two figures are given below, the first applies to the NACA machine and the second to the BRL machine.)

COPIES AVAILABLE:
PROGRAMMING SERVICE: Available at BRL to groups engaged in national defense work.
COMPUTING TIME: Available at BRL to groups engaged in national defense work.
FLOOR AREA: 1150/1600 sq. ft. POWER CONSUMPTION: 23/5 kw.
COOLING: 7½-ton a.cond./None FIRST READY FOR USE: 1946/1947.
BEST SUITED FOR: General-purpose, repetitive computing with little input.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk	1.0/1.5	0.6/0	100/81.7	0.1/1.0	3.3/8.0	6.9/1.8	112/94.0
Percent	0.9/1.6	0.5/0	89.4/86.9	0.1/1.1	2.9/8.5	6.2/1.9	100%

PERSONNEL: NACA: 1 operator, 3 maintenance men, 4 mathematicians, 1 clerical, 1 in training for maintenance.
BRL: 1 maintenance man, 2 mathematicians.
NUMBER BASE: 10 (biquinary code). One of 2 & 1 of 5 relays must close for each decimal digit.
WORD LENGTH: Sign and 7 significant decimal digits and exponent of -19 to 19.
NUMBER RANGE: $\pm 10^{-20}$ to $\pm 10^{19}$. INSTRUCTION TYPE: Three-address.
NEGATIVE NO. REP.: Magnitude and sign. SEQUENCE CONTROL: Punched paper tape.
OPERATIONS: Addition, subtraction, multiplication, division. There are tables permanently built into the machine for the sine, cosine, inverse tangent, common logarithm, and antilogarithm.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	0.07 s	0.3 sec	0.3 sec	0.3 sec			
	Max.	0.07 s	0.3 sec	1.0 sec	2.2 sec			
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Relays	Internal	15		70 ms	70 ms	Parallel		
Punched tape	External	Unltd.	Usually up to 1½ min.					2"/sec.

INPUT/OUTPUT:

Type	Function	Speed
Paper tape	In & Out	20 frames per second
Typewriter	Output	6 characters per second

TAPE SEARCH: Possible in either direction.
ARITHMETIC MODE: Parallel. CLOCK FREQ.:
COMPUTING ELEMENT: Relays.
COMPONENTS: 5000 relays in each of the two computers comprising each installation.
REMARKS: The operating schedules refer to the average for the two. At NACA they are attended only 80 hrs/wk, at BRL 40. The erroneous time is due entirely to human errors; the idle time is due to stopping during unattended operation. See F. L. Alt, Mathematical Tables and Other Aids to Computation, no. 21, pp. 1-13 (January 1948), and no. 22, pp. 69-84 (April 1948).

BUILT BY: Bell Telephone Laboratories, Murray Hill, New Jersey.
INSTALLATIONS: Bell Telephone Laboratories.

COPIES AVAILABLE:
PROGRAMMING SERVICE:
COMPUTING TIME:
FLOOR AREA: 12 bays POWER CONSUMPTION:
COOLING: FIRST READY FOR USE: 1949
BEST SUITED FOR: General purpose; network analysis and matrix calculations.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 10 (biquinary code).
WORD LENGTH: Sign & 3-, 6-, or 10-dec.-digit factor and exponent -19 to 19.
NUMBER RANGE: $\pm 10^{-19}$ to $\pm 10^{20}$. INSTRUCTION TYPE: Three-address.
NEGATIVE NO. REP.: Magnitude and sign. SEQUENCE CONTROL: Paper tape.
OPERATIONS: There is provision for wiring in 200 subroutines of up to 20 steps by passing 2000 insulated wires through the appropriate coils. Trigonometric, logarithmic, complex, impedance, and admittance routines are thus immediately available at all times.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.							
	Max.							
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time		Mode	Drum Diam., Length or CRT Type	Speed of Motion
				Max.	Min.			

INPUT/OUTPUT:

Type	Function	Speed
Punched tape	Input	There is provision for 3
Teletypewriter	Output	remote-control stations.

TAPE SEARCH:
ARITHMETIC MODE: CLOCK FREQ.:
COMPUTING ELEMENT: Relays.
COMPONENTS: 4300 relays and 86 cold-cathode tubes.
REMARKS: When the checking circuits fail to indicate satisfactory operation, the computer automatically goes back and tries again. Since failures are often due to transient relay-contact failure, the second attempt is generally successful.

BUILT BY: Bendix Computer Division, Bendix Aviation Corp.
INSTALLATIONS: Bendix Computer Division, Los Angeles, Calif.

COPIES AVAILABLE: No.
PROGRAMMING SERVICE: Yes.
COMPUTING TIME: No.
FLOOR AREA: 20 sq. ft. POWER CONSUMPTION: 4 kw.
COOLING: FIRST READY FOR USE: January 1954.
BEST SUITED FOR: Solution of differential equations.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING				
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair	Idle	Total
Hrs/Wk	3	1	30	1	3	2	40
Percent	7.5	2.5	75.0	2.5	7.5	5.0	100

PERSONNEL: 1 operator, 1 maintenance man, 3 mathematicians.

NUMBER BASE: 10 (excess-3).
WORD LENGTH: 6 decimal digits.
NUMBER RANGE: Variable. INSTRUCTION TYPE:
NEGATIVE NO. REP.: Complement. SEQUENCE CONTROL: Special drum store.
OPERATIONS: Add dy_m to y_m and multiply by dx_n.
The computer has 60 integrators.

SPEED:

		Transfer	Addition	Multiplication	Division	Iteration		
Incl. Access	Min.					10 ms		
	Max.					10 ms		
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic Drum	Internal		15				13"dia.	3000rpm
							2"long	

INPUT/OUTPUT:

Type	Function	Speed
Tape Reader	Input	
Tape Punch	Output	
Typewriter	Output	10 characters/sec.

TAPE SEARCH: Possible in reverse direction.
ARITHMETIC MODE: Serio-parallel. CLOCK FREQ.: 204 kc.
COMPUTING ELEMENT:
COMPONENTS: Number of tubes not yet determined, 2400 crystals.
REMARKS: Can compute new initial conditions during each solution and recompute the solution with the new initial conditions.

BESK
(Binär Elektronisk Sekvens-Kalkylator)

BUILT BY: Matematikmaskinnämndens Arbetsgrup, Kunglig Tekniska Högskola Stockholm, Sweden
INSTALLATIONS: Kunglig Tekniska Högskola
(This group is supported by the Swedish Board for Computing Machinery.)

COPIES AVAILABLE: No.
PROGRAMMING SERVICE:
COMPUTING TIME:
FLOOR AREA: About 70 sq. ft. POWER CONSUMPTION: 14 kw.
COOLING: 2000 cfm. FIRST READY FOR USE: 1954.
BEST SUITED FOR: General purpose; government, scientific, & industrial computing.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2 (10 externally).
WORD LENGTH: 40 binary digits (instructions 20 binary digits).
NUMBER RANGE: -1 to 1. INSTRUCTION TYPE: One-address.
NEGATIVE NO. REP.: Twos' complement. SEQUENCE CONTROL: General store.
OPERATIONS: Addition, subtraction, multiplication, logical multiplication, shift.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	50 μs	50 μs	300 μs				
	Max.	50 μs	50 μs					
Excl. of Access			6 μs	250 μs				

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Electrostatic(Wms.)	Internal	256	40	25 μs	12½ μs	Parallel	1 5UP1 2 drums	
Magnetic drum	External	8192	256	20 ms	0.6ms	Serial	4-3/4" dia x 13" long	3000rpm

INPUT/OUTPUT:

Type	Function	Speed
Dielectric paper-tape reader	Input	200 frames/sec.
Typewriter	Output	10 characters/sec.

TAPE SEARCH: None.
ARITHMETIC MODE: Parallel CLOCK FREQ.: 160 kc.
COMPUTING ELEMENT: Triodes and diodes.
COMPONENTS: 2250 tubes, 200 crystal rectifiers.
REMARKS: It is hoped to double the spot density on the cathode-ray tubes and obtain a 512-word memory.

BINAC
(Binary Automatic Computer)

BUILT BY: Eckert-Mauchly Division (Remington Rand Inc.), Philadelphia, Penn.
INSTALLATIONS: Northrop Aircraft Corporation, Hawthorne, California

COPIES AVAILABLE:
PROGRAMMING SERVICE:
COMPUTING TIME:
FLOOR AREA: 20 sq. ft. POWER CONSUMPTION:
COOLING: FIRST READY FOR USE: August, 1949.
BEST SUITED FOR: General purpose.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2 (8 externally).
WORD LENGTH: 30 binary digits & sign (instructions 15 binary digits).
NUMBER RANGE: -1 to 1 INSTRUCTION TYPE: One-address.
NEGATIVE NO. REP.: Twos' complement. SEQUENCE CONTROL: General store.
OPERATIONS: Add, subtract, multiply, divide, transfer; transfer control, input, output, stop.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.							
	Max.		800 μs	1200 μs	1200 μs			
Excl. of Access			285 μs	1000 μs	1000 μs			

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Mercury delay lines	Internal	512	16	336 μs	10.5 μs	Serial	32 words	

INPUT/OUTPUT:

Type	Function	Speed
Keyboard	Input	
Magnetic tape	In-out	Written on only by computer.
Typewriter	Output	

TAPE SEARCH: None. The tape is controlled manually.
ARITHMETIC MODE: Serial. CLOCK FREQ.: 4 mc.
COMPUTING ELEMENT: Tubes.
COMPONENTS: 700 tubes.
REMARKS: See A. A. Auerbach, J. P. Eckert, Jr., R. F. Shaw, J. R. Weiner, L. D. Wilson, "The Binac", Proc. I.R.E., Vol. 40, pp. 12-29, (Jan. 1952). The storage and arithmetic units are completely duplicated; a difference during computation stops the computer.

BUILT BY: Burroughs Adding Machine Co., Philadelphia, Pennsylvania
INSTALLATIONS: Wayne University Computation Laboratory, Detroit, Michigan.

COPIES AVAILABLE: Not available.
PROGRAMMING SERVICE: Available.
COMPUTING TIME: Available.
FLOOR AREA: 1200 sq. ft. POWER CONSUMPTION: 35 kw.
COOLING: FIRST READY FOR USE: February 1951.
BEST SUITED FOR: General purpose

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk	4	4	29		3		40
Percent	10	10	72.5		7.5		100

PERSONNEL: 1 operator, 2 maintenance, 4 mathematicians.

NUMBER BASE: 10 (excess-three code)
WORD LENGTH: 9 decimal digits wd.
NUMBER RANGE: Dec. pt. anywhere in / INSTRUCTION TYPE: One or two-address (Programmable change).
NEGATIVE NO. REP.: Complement SEQUENCE CONTROL: General store
OPERATIONS: Add, subtract, multiply, divide, compare, extract, shift, input-output.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.		17 ms	50 ms				
	Max.		0.6 ms	30 ms				
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic Drum	Internal	800	16	32 ms		Serial	8" dia.	1800rpm

INPUT/OUTPUT:

Type	Function	Speed
Teletype	In-Out	6 char/sec
Photoelectric tape reader	Input	100 char/sec

TAPE SEARCH:
ARITHMETIC MODE: Serial. CLOCK FREQ.: 125 kc
COMPUTING ELEMENT:
COMPONENTS: 3271 tubes, 6773 crystal rectifiers.
REMARKS: This computer was assembled from Burroughs Pulse Control Units. These units are available separately. The computer has an automatic word-check digit which is a weighted count of bits modulo 3. It also has an arithmetic overflow check and tape synchronism check.

CADAC 102
(Cambridge Digital Automatic Computer)

BUILT BY: Computer Research Corporation, Hawthorne, California.
INSTALLATIONS: Project Lincoln. Massachusetts Institute of Technology. (Owned by the Air Force Cambridge Research Center.)

COPIES AVAILABLE: No.
PROGRAMMING SERVICE: Not available.
COMPUTING TIME: Not available.
FLOOR AREA: $3\frac{1}{2}$ ft x $2\frac{1}{2}$ ft. POWER CONSUMPTION: 5 kw.
COOLING: Built in. FIRST READY FOR USE: January 1952.
BEST SUITED FOR: General-purpose computation not requiring large storage.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2 (8 externally).
WORD LENGTH: 36 binary digits (instructions 42 binary digits).
NUMBER RANGE: -1 to 1. INSTRUCTION TYPE: Three-address.
NEGATIVE NO. REP.: Magnitude and sign. SEQUENCE CONTROL: General store.
OPERATIONS: Reasonable set of three-address commands, primarily lacking in input-output commands.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	AVERAGE	55 ms	65 ms	95 ms	95 ms			
	Max.							
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic drum	Internal	1024	16	25 ms	0	Serial	12"dia.	2400rpm

INPUT/OUTPUT:

Type	Function	Speed
Keyboard	Input	
Typewriter	Output	10 digits per second.

TAPE SEARCH:
ARITHMETIC MODE: Serial. CLOCK FREQ.: 100 kc.
COMPUTING ELEMENT: Crystal diodes and flip flops.
COMPONENTS: 195 tubes, 2500 crystal rectifiers, and 10 relays.
REMARKS: During the first four months of operation, covering 170 hours of operating time, three faults occurred, requiring $1\frac{1}{2}$ hours for their repair.

BUILT BY: Computer Research Corporation, Hawthorne, California.

INSTALLATIONS: #1 Special order.
#2 & #4 Army Ord., White Sands Proving Ground, Las Cruces, N.M.
#3 Rand Corp., Santa Monica, Calif.
#5 Naval Ord. Test Station, Inyokern, Calif.
#6 Army Chem. Center, Edgewood, Md.
#7 CRC Computing Center.
#8 USN P-G School, Monterey, Calif.
#9 Gulf Res. & Dev. Co., Pittsburgh, Penna.
#10 Prudential Ins.Co., Newark, N.J.

COPIES AVAILABLE: For sale or rent.

PROGRAMMING SERVICE: Available.

COMPUTING TIME: Available.

FLOOR AREA: 8 sq. ft. POWER CONSUMPTION: 6 kw.

COOLING: Internal fan. FIRST READY FOR USE: May 1953.

BEST SUITED FOR: General purpose.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk	8	0	132	24		0	168
Percent	4	0	82	14		0	100%

PERSONNEL: The foregoing operating schedule is guaranteed in the lease. Estimated personnel requirements are: 1 operator, ½ maintenance man, and mathematician(s).

NUMBER BASE: 2 (8 or 10 externally--8,4,2,1 code).

WORD LENGTH: 36 binary digits (instructions 42 binary digits).

NUMBER RANGE: -1 to 1. INSTRUCTION TYPE: Three-address.

NEGATIVE NO. REP.: Magnitude and sign. SEQUENCE CONTROL: General store.

OPERATIONS: Full set of arithmetic, logical, and input-output orders.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	AVERAGE Min.	12½ ms	12½ ms	25 ms	25 ms			
	Max.							
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic drum	Internal	1024	16	25 ms	0	Serial	12"dia.	2400rpm
Drum buffer	Internal	8	1	3.1ms	0	Serial		
Magnetic tape	External	800,000	5	2 min.	0	Ser-par	1200 ft	7½'/sec

INPUT/OUTPUT:

Type	Function	Speed
Keyboard	Input	
Magnetic tape	In& Out	60 words per second
Punched cards	In& Out	1 card (4 wds, 56 cols)/sec
Punched paper tape	In& Out	1 word (10 6-bit chars)/sec

TAPE SEARCH: Possible in either direction on several tapes during computing.

ARITHMETIC MODE: Serial. CLOCK FREQ.: 100 kc.

COMPUTING ELEMENT: Crystal diodes and flip-flops.

COMPONENTS: 300 tubes and about 4000 crystal rectifiers.

REMARKS: The computer will halt automatically on unprogrammed overflow and on number pick-up instead of command.

CALDIC
(California Digital Computer)

BUILT BY: Electrical Engineering Division, Univ. of Calif., Berkeley
INSTALLATIONS: University of California
(The Office of Naval Research contributed financial support to the development of the computer.)

COPIES AVAILABLE: No (but plans and drawings will be available).
PROGRAMMING SERVICE: Will be generally available.
COMPUTING TIME: Will be generally available.
FLOOR AREA: 100 sq. ft. POWER CONSUMPTION: 10 kw.
COOLING: None. FIRST READY FOR USE: Summer 1953.
BEST SUITED FOR: General purpose (large memory, small output, moderate speed).

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 10 (8-4-2-1).
WORD LENGTH: 10 decimal digits and sign (instructions 6 decimal digits).
NUMBER RANGE: -1 to 1. INSTRUCTION TYPE: One-address
NEGATIVE NO. REP.: Absolute value & sign. SEQUENCE CONTROL: General store.
OPERATIONS: Add, subtract, multiply, divide, square root, plus subprogram and conditional subprogram operations. (Multiply and divide operations provide for either rounded or full length results.)

SPEED:		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	600 μs	600 μs	5 ms	10 ms			
	Max.	17 ms	17 ms	34 ms	34 ms			
Excl. of Access		84 μs	336 μs	5 ms	10 ms			

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic Drum	Internal	10,000	200	17 ms	160 μs	Ser-Par.	8"dia., 26"long	3600rpm

INPUT/OUTPUT:

Type	Function	Speed
Photo-electric Tape Reader	Input	600 decimal digits/sec.
Flexowriter Punch	Output	10 decimal digits/sec.

TAPE SEARCH: None.
ARITHMETIC MODE: Serio-parallel. CLOCK FREQ.: 144 kc.
COMPUTING ELEMENT: Diode adder (decimal).
COMPONENTS: 1100 tubes, 1300 crystal rectifiers (12 relays in power supply).
REMARKS: Financial support of research and development personnel from ONR. Equipment furnished by University of California. See P. M. Morton, "The California Digital Computer," Mathematical Tables and other Aids to Computation, V, No. 34, pp 57-61, (April 1951).

BUILT BY: Hogan Laboratories, Inc., New York, New York.
INSTALLATIONS: Westinghouse Electric Corp. (WAPD) (owned by AEC), Pittsburgh, Pa.
Johns Hopkins University (ORO) (owned by U.S. Army), Chevy Chase, Md.
New York University, New York City, N.Y.
Nuclear Development Associates, White Plains, N.Y.

COPIES AVAILABLE: For sale - for rent at a later date.
PROGRAMMING SERVICE: Available.
COMPUTING TIME:
FLOOR AREA: 15 sq. ft. POWER CONSUMPTION: 3.5 kw.
COOLING: 1000 cfm built-in. FIRST READY FOR USE: March 1953
BEST SUITED FOR: General-purpose, scientific computing.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2 (externally 10 and 16).
WORD LENGTH: 41 binary digits (instructions 20 digits).
NUMBER RANGE: -1 to 1. INSTRUCTION TYPE: One-address.
NEGATIVE NO. REP.: Complement. SEQUENCE CONTROL: General-store.
OPERATIONS: Addition, subtraction, multiplication (with and without round-off) division, transfers, decimal-binary conversion, shift, 3 transfer of control, input-output.

SPEED:

		Transfer	Addition	Multiplication	Division	Dec.-Bin. Conversion		
Incl. Access	Min.	8 ms	17 ms	34 ms	34 ms	34 ms		
	Max.	25 ms	34 ms	68 ms	68 ms	68 ms		
Excl. of Access		8 ms	17 ms	34 ms	34 ms	34 ms		

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time		Mode	Drum Diam., Length or CRT Type	Speed of Motion
				Max.	Min.			
Magnetic Drum	Internal	1000 to ~~4000~~	32 to ~~128~~	17 ms	$\frac{1}{2}$ ms	Serial	8"x8"	59 rps

INPUT/OUTPUT:

Type	Function	Speed
Flexowriter Equipment	In-Out	10 characters/second including binary-decimal conversion

TAPE SEARCH:
ARITHMETIC MODE: Serial. CLOCK FREQ.: 80 kc.
COMPUTING ELEMENT: Flip-flop.
COMPONENTS: 700 tubes.
REMARKS: The Circle Computer was developed under the auspices of Hogan Laboratories, New York University, and Nuclear Development Associates.

BUILT BY: Consolidated Engineering Corporation, Pasadena, California
INSTALLATIONS: Consolidated Engineering Corporation

COPIES AVAILABLE: For sale, possibly for rent.
PROGRAMMING SERVICE: Possibly available.
COMPUTING TIME: Possibly available.
FLOOR AREA: 150 sq. ft. POWER CONSUMPTION: 7 kva.
COOLING: 2000 cfm built in. FIRST READY FOR USE: May 1953
BEST SUITED FOR: General-purpose mathematical and scientific computation.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING				
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair	Idle	Total
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 10 (8-4-2-1 representation)
WORD LENGTH: 10 dec. digits
NUMBER RANGE: -1 to 1 INSTRUCTION TYPE: 1 address
NEGATIVE NO. REP.: Sign & abs. value SEQUENCE CONTROL: General store
OPERATIONS: Addition, subtraction, multiplication, division, floating-point operations, logical multiplication, comparison, transfer control, input-output.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	0.3 ms	0.6 ms	9.0 ms	12.4 ms			
	AVERAGE	2 ms	2 ms	8.5 ms	12.5 ms	(Average from loops)		
Excl. of Access		0.09 ms	0.3 ms	8.8 ms	12.2 ms			

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic drum	Internal	80	4 recirculating loops of 4 tracks each	1.7ms		Ser-par	12" dia 14" long	3500rpm
	Internal	4000		17ms		Ser-par		

INPUT/OUTPUT:

Type	Function	Speed
Photoelectric tape reader	Input	450 dec. digits/sec.
Tape perforator	Output	12 dec. digits/sec.
Typewriter	Output	8 dec. digits/sec.

TAPE SEARCH: None
ARITHMETIC MODE: Serio-parallel CLOCK FREQ.: 140 kc
COMPUTING ELEMENT: Flip-flop
COMPONENTS: 1200 tubes, 3000 crystal rectifiers
REMARKS: The "loops" on the drum recirculate information between magnetic heads spaced 1/10 of the drum periphery apart. Automatic checks are built in for add-substract overflow, forbidden 4-bit codes, and improper divisions (dividend larger than division). A special 4-digit register facilitates alteration of addresses, floating-point programming, and tallying of repetitive cycles.

CRC 105
Decimal Digital Differential Analyzer

BUILT BY: Computer Research Corporation, Hawthorne, California.

INSTALLATIONS: Army Ord., Ballistic Research Labs., Aberdeen Proving Ground, Md.
Navy Bureau of Ordnance, Washington, D.C.
Lockheed Aircraft, Burbank, California.
Naval Ordnance Test Station, Pasadena, California.
Holloman Air Force Base, Alamogordo, New Mexico.
(Army Ord. contributed support to the development of the computer.

COPIES AVAILABLE: For sale or rent.

PROGRAMMING SERVICE: Not available.

COMPUTING TIME: Not available.

FLOOR AREA: 8 sq. ft. POWER CONSUMPTION: 7 kw.

COOLING: Internal fan. FIRST READY FOR USE: February 1953.

BEST SUITED FOR: Solution of ordinary and some partial differential equations.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 10 (2*,4,2,1 code).

WORD LENGTH: 6 decimal digits for numbers.

NUMBER RANGE: 1 to 10^6 or 10^{-6} to 1 INSTRUCTION TYPE: Special.

NEGATIVE NO. REP.: Tens' complement. SEQUENCE CONTROL: Special drum store.

OPERATIONS: Step-by-step integration of ordinary differential equations.
Limiting, servo, decision, and other uses of integrators.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	Sixty integrations are performed per drum revolution (1/60 sec)						
	Max.	involving six simultaneous arithmetic operations per integrator.						
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic drum	Internal	60 integrators	8			Serial	9" dia.	3600 rpm

INPUT/OUTPUT:

Type	Function	Speed
Keyboard	Input	
Graph follower	Input	20 increments per second.
Graph plotter	Output	20 increments per second.
Flexowriter	Output	10 characters per second.

TAPE SEARCH:

ARITHMETIC MODE: Serial. CLOCK FREQ.: 100 kc.

COMPUTING ELEMENT: Crystal diodes and flip-flops.

COMPONENTS: About 200 tubes and 3000 crystal rectifiers.

REMARKS: This computer is of the MADDIDA type.

CRC 107
General-Purpose Computer

BUILT BY: Computer Research Corporation, Hawthorne, California.
INSTALLATIONS: Army Ordnance, White Sands Proving Ground, Las Cruces, N.M.(Whitesac)
Navy Bureau of Aeronautics, Washington, D.C.

COPIES AVAILABLE: For sale.
PROGRAMMING SERVICE: Not available.
COMPUTING TIME: Not available.
FLOOR AREA: 500 sq. ft. POWER CONSUMPTION: 18 kw.
COOLING: Waste-water cooled. FIRST READY FOR USE: April 1953.
BEST SUITED FOR: General purpose; problems requiring large storage.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 10 (excess-three code).
WORD LENGTH: 9 decimal digits and sign (instructions 11 decimal digits).
NUMBER RANGE: -1 to 1. INSTRUCTION TYPE: Three-address.
NEGATIVE NO. REP.: Magnitude and sign. SEQUENCE CONTROL: General store.
OPERATIONS: Addition, subtraction, multiplication, division, shift, logical and magnitude extraction, overflow test, algebraic comparison, equivalence, input, output.

SPEED:

		Transfer	Addition	Multiplication	Division	Shift	Extract	Compare
Incl. Access	AVERAGE	12 ms	15 ms	40 ms	40 ms	16 ms	15 ms	12 ms
	Max.							
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic drum	Internal	1000	10	4 ms	0	Serial	20"dia.	1500rpm
Magnetic drum	External	10,000	100	40 ms	0	Serial	20"dia.	1500rpm
Magnetic tape	External	1,000,000	5	80 sec	0	Serial	1200 ft.	$7\frac{1}{2}$'/sec

INPUT/OUTPUT:

Type	Function	Speed
Keyboard	Input	
Punched tape, Typewriter	In& Out	1 word per second
Magnetic tape, H-S printer	In& Out	100 words per second
Punched cards (80 columns)	In&Out	2 cards (16 words) per sec.

TAPE SEARCH: Possible in either direction on several tapes while computing.
ARITHMETIC MODE: Serial. CLOCK FREQ.: 100 kc.
COMPUTING ELEMENT: Crystal diodes and flip-flops.
COMPONENTS: 850 tubes, 8000 crystal rectifiers, 50 relays.
REMARKS: The internal-storage access time is decimated by the use of 10 heads per channel. Checks are incorporated for forbidden digits, unprogrammed overflow, and number pick-up instead of command.

BUILT BY: Div. of Radiophysics, Commonwealth Scientific & Industrial Research Organization (Australia)
INSTALLATIONS: Div. of Radiophysics, C.S.I.R.O.

COPIES AVAILABLE: Not available.
PROGRAMMING SERVICE: Not available.
COMPUTING TIME: Available to local research centers.
FLOOR AREA: 400 sq. ft. POWER CONSUMPTION: 15 kva.
COOLING: FIRST READY FOR USE: October 1951.
BEST SUITED FOR: Matrix operations, differential equations, function tables, data analysis.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING				
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair	Idle	Total
Hrs/Wk							
Percent							

PERSONNEL: 1 operator, 2 maintenance, 2 mathematicians, 1 clerical.

NUMBER BASE: 2 (2 or 10 externally).
WORD LENGTH: 20 bits.
NUMBER RANGE: -1 to 1 INSTRUCTION TYPE: One-address
NEGATIVE NO. REP.: Complement. SEQUENCE CONTROL: General store.
OPERATIONS: Division must be programmed.

SPEED:		Transfer	Addition	Multiplication	Division	Transfer	Low-Speed Store
Incl. Access	Min.	2 ms	2 ms	5 ms			2 ms
	Max.	4 ms	4 ms	6 ms			20 ms
Excl. of Access		360 μs	360 μs	4 ms			

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Acoustic Delay Line	Internal	1024	64	960 μs	60 μs	Serial	.5" long	
Magnetic Drum	Internal	4096	40	20 ms		Parallel	9" dia.	3000 rpm

INPUT/OUTPUT:

Type	Function	Speed
Paper Tape	Input	15-20 rows of 10 digits/sec.
Paper Tape	Output	3 rows of 10 digits/sec.
		(These figures estimated.)

TAPE SEARCH: None
ARITHMETIC MODE: Serial. CLOCK FREQ.: 333 kc.
COMPUTING ELEMENT:
COMPONENTS: 1800 tubes, 1500 crystal rectifiers, 30 relays.
REMARKS: See T. Pearcey, "An Automatic Computer in Australia," Mathematical Tables and other Aids to Computation, VI, No. 39, pp 167-172, (July 1952).

CUBA

(Calculateur Universel Binaire de l'Armement)

BUILT BY: Société d'Électronique et d'Automatisme, Paris, France

INSTALLATIONS: Laboratoire Central de l'Armement, Paris, France

COPIES AVAILABLE:

PROGRAMMING SERVICE:

COMPUTING TIME:

FLOOR AREA: 1000 sq. ft. POWER CONSUMPTION: 25 kw

COOLING: FIRST READY FOR USE: January 1954

BEST SUITED FOR:

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2 (10 externally)

WORD LENGTH: 25 or 50 binary digits (instructions 25 binary digits)

NUMBER RANGE: INSTRUCTION TYPE: Two-address

NEGATIVE NO. REP.: Complement except in SEQUENCE CONTROL: General store

OPERATIONS: multiplier

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	2 ms	2 ms	2 ms				
	Max.	35 ms	35 ms	35 ms				
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time		Mode	Drum Diam., Length or CRT Type	Speed of Motion
				Max.	Min.			
Magnetic drum	Internal	32,768	256	34ms		Serial	10"	1800rpm
Electromagnetic delay lines	Internal	16	16			Serial		
Magnetic triggers (future)	Internal	256						

INPUT/OUTPUT:

Type	Function	Speed
Photoelectric tape reader	Input	200 characters/sec.
Tape punch	Output	18 characters/sec.
Teleprinter	Output	5 characters/sec.

TAPE SEARCH:

ARITHMETIC MODE: Serial CLOCK FREQ.: 100 kc

COMPUTING ELEMENT: Germanium diodes

COMPONENTS:

REMARKS:

DYSEAC
(Second SEAC)

BUILT BY: Electronic Computer Laboratory, National Bureau of Standards, Washington, D. C.
INSTALLATIONS:

COPIES AVAILABLE: No.
PROGRAMMING SERVICE: Availability not yet determined.
COMPUTING TIME: Availability not yet determined.
FLOOR AREA: 200 sq. ft. POWER CONSUMPTION: 20 kw.
COOLING: 4000 cu.ft./min. FIRST READY FOR USE: July, 1953, at the earliest.
BEST SUITED FOR: General-purpose, simulation, some classes of real-time control.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2 internally; 2, 16, externally; alphameric input/output.
WORD LENGTH: 45 binary digits, sign digit, and check digit.
NUMBER RANGE: -4 to 4. INSTRUCTION TYPE: Three-address.
NEGATIVE NO. REP.: Abs. value & sign. SEQUENCE CONTROL: General storage.
OPERATIONS: Arithmetic, choice, program control, input-output. Operations include summation, accumulation, justification, shift, and storage and reset of contents of program counters ("file").

SPEED:

		Transfer	Addition	Multiplication	Division	File		
Incl. Access	Min.	millisec.	0.2	2.4	2.4	0.1		
	Max.		1.5	3.6	3.6	0.8		
Excl. of Access			0.05	2.1	2.1	0.05		

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Hg Delay Line	Internal	512	64	384 μs	48 μs	Serial	8 words	
Magnetic Tapes or Huth Wire Bottles	External	13000es. 20000es.	1 1		0.1 sec 0.1 sec	Serial Serial	1200' 2000'	5'/sec. 8'/sec.
Magnetic Drum	External	8500	240	17 ms	0.4 sec.	Serial		3600 rpm

INPUT/OUTPUT:

Type	Function	Speed
Flexowriter Keyb'd & Printer	In-Out	10 characters/second
Punched Paper Tape	In-Out	10 characters/second
Magnetic Wire (Peirce)	In-Out	3500 digits/second

TAPE SEARCH: Possible in both directions.
ARITHMETIC MODE: Serial. CLOCK FREQ.: 1 megacycle.
COMPUTING ELEMENT: Germanium diode switches, tube amplifiers, and delay lines.
COMPONENTS: 500 tubes in computer plus 350 in each memory cabinet; 20,500 crystal rectifiers.
REMARKS: Input and output can proceed concurrently with arithmetic. Provision is made for octupling the accustic memory and for up to 16 magnetic tapes. An odd-even memory check is built in. For further information, see NBS Report 1951, "System specifications for the DYSEAC," by Alan L. Leiner, Sept., 1952.

EDPM Type 701
(Electronic Data Processing Machines)

BUILT BY: International Business Machines Corporation

INSTALLATIONS: 18 government agencies and commercial organizations will have installations by March 1954.

COPIES AVAILABLE: For rent

PROGRAMMING SERVICE: Available. Instruction in programming given each month.

COMPUTING TIME: Available.

FLOOR AREA: POWER CONSUMPTION: 88 kva (80 kw)

COOLING: FIRST READY FOR USE: April 1953

BEST SUITED FOR: General purpose

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk	Varies according to installation.						
Percent							

PERSONNEL: Varies according to installation; complete maintenance furnished by IBM.

NUMBER BASE: 2 (usually 10 externally)

WORD LENGTH: 36 binary digits (instructions 18 binary digits)

NUMBER RANGE: Variable binary pt. INSTRUCTION TYPE: One-address

NEGATIVE NO. REP.: Sign & abs. value SEQUENCE CONTROL: General store

OPERATIONS: Addition, subtraction, multiplication, division, round, shift, transfer, test for zero or negative

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	36 μs	36 μs	500 μs	500 μs			
	Max.	60 μs	60 μs	500 μs	500 μs			
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Electrostatic	Internal	2048	72	12 μs		Parallel		
Magnetic drum	Internal	8192	144			Parallel		
Magnetic tape						Ser-Par		

INPUT/OUTPUT:

Type	Function	Speed
Magnetic tape	In-Out	1250 words per sec.
Card reader	Input	Up to 150 72-column cards/min.
Card punch	Output	Up to 100 72-column cards/min.
Printer	Output	Up to 150 72-column cards/min.

TAPE SEARCH: Reading possible in both directions

ARITHMETIC MODE: Parallel CLOCK FREQ.: 1 mc

COMPUTING ELEMENT: Flip-flop

COMPONENTS: 4000 tubes; 15,000 crystal rectifiers

REMARKS: A redundancy-bit check is used on the magnetic tapes. Counter overflow, division, and printing checks are incorporated. A card may contain either 72 decimal or alphameric characters or 24 36-bit words. The 701 is the Electronic Analytical Control Unit, the 706 is the Electrostatic Storage Unit, the 711 is the Punched Card Reader, the 716 is the Alphabetic Printer, the 721 is the Punched Card Recorder, the 726 is the Magnetic Tape Reader and Recorder (2 tapes), and the 731 is the Magnetic Drum Storage.

EDSAC I
(Electronic Delay Storage Automatic Computer)

BUILT BY: University Mathematical Laboratory, Cambridge, England
INSTALLATIONS: University Mathematical Laboratory
(Cambridge University contributed to the development of the computer. LEO, installed at J. Lyons Co., London, is an engineered version of EDSAC I.)

COPIES AVAILABLE: No.
PROGRAMMING SERVICE:
COMPUTING TIME: Not available.
FLOOR AREA: 12' x 12'. POWER CONSUMPTION: 15 kw.
COOLING: Window fan. FIRST READY FOR USE: June 1949.
BEST SUITED FOR: General-purpose.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2 (10 externally).
WORD LENGTH: 34 or 17 binary digits and sign (instructions 17 binary digits).
NUMBER RANGE: -1 to 1. INSTRUCTION TYPE: One-address.
NEGATIVE NO. REP.: Complement. SEQUENCE CONTROL: General store.
OPERATIONS: Add, subtract, multiply, shift, "and".

SPEED:		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.							
	[illegible]	1.5 ms	1.5 ms	6.0 ms				
Excl. of Access								

STORAGE: Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Mercury Delay Lines	Internal	1024 (17-digit words)	32	about 600 μs		Serial		
Magnetic Tape	External		2					

INPUT/OUTPUT:

Type	Function	Speed
Paper Tape (5-hole)	Input	40-50 rows/second
Paper Tape (5-hole)	Output	18 rows/second

TAPE SEARCH:
ARITHMETIC MODE: Serial. CLOCK FREQ.: 500 kc.
COMPUTING ELEMENT: Tubes.
COMPONENTS: 4500 tubes.
REMARKS: EDSAC I has refined marginal-checking facilities. See M. V. Wilkes, David J. Wheeler, and Stanley Gill, The Preparation of Programs for an Electronic Digital Computer, Addison-Wesley Press Inc., Cambridge, Massachusetts (1951).

EDVAC
(Electronic Discrete Variable Automatic Computer)

BUILT BY: Moore School, University of Pennsylvania
INSTALLATIONS: Ballistic Research Laboratories, Aberdeen Proving Ground, Maryland (Owned by Army Ordnance Corps.)

COPIES AVAILABLE: No.
PROGRAMMING SERVICE: Available to groups engaged in National Defense work.
COMPUTING TIME:
FLOOR AREA: 1200 sq. ft. POWER CONSUMPTION: 50 kw.
COOLING: 12-ton air conditioner. FIRST READY FOR USE: April 1952.
BEST SUITED FOR:

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk	9.4	25	40	5	70.4	2.4	152.2
Percent	6.2	16.4	26.3	3.3	46.2	1.6	100

PERSONNEL: 10 maintenance men, 12 mathematicians.

NUMBER BASE: 2
WORD LENGTH: 44 binary digits.
NUMBER RANGE: $2^{-43}-1$ to $1-2^{-43}$. INSTRUCTION TYPE: Four-address.
NEGATIVE NO. REP.: Sign bit. SEQUENCE CONTROL: General store.
OPERATIONS:

SPEED:

		Transfer	Addition	Multiplication	Division	Compare		
Incl. Access	Min.		192 μs	2.2 ms	2.2 ms	192 μs		
	Max.		1.5 ms	3.5 ms	3.6 ms	1.2 ms		
Excl. of Access			48 μs	2.0 ms				

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Mercury Delay Line	Internal	1024	128	384 μs		Serial		1 mega-cycle

INPUT/OUTPUT:

Type	Function	Speed
Teletype Tape		

TAPE SEARCH:
ARITHMETIC MODE: Serial. CLOCK FREQ.: 996.75 kc.
COMPUTING ELEMENT:
COMPONENTS: 3600 tubes, 10,000 crystals.
REMARKS: Duplicate algebraic units provide checking.

BUILT BY: Electronic Computer Division, Underwood Corporation, New York, N.Y.
INSTALLATIONS: Development and Proof Services, Fire Control Branch, Aberdeen Proving Ground, Maryland.(Owned by Ordnance Corps, U.S. Army.)
Project Cyclone, Reeves Instrument Co., New York, N. Y.

COPIES AVAILABLE: For sale.
PROGRAMMING SERVICE:
COMPUTING TIME:
FLOOR AREA: 25 sq. ft. POWER CONSUMPTION: 3 kva.
COOLING: None required. FIRST READY FOR USE: November 1952.
BEST SUITED FOR: General numerical computation.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL: 1 mathematician, 1 maintenance man at APG.

NUMBER BASE: 2 (8 and 10 externally).
WORD LENGTH: 30 binary digits.
NUMBER RANGE: $(2^{-27}-4)$ to $4-2^{-27}$). INSTRUCTION TYPE: Three-address.
NEGATIVE NO. REP.: Complement. SEQUENCE CONTROL: General store.
OPERATIONS: Addition, subtraction, multiplication (rounded and double-precision), logical multiplication, transfer, input-output, no divide.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	2 ms	3 ms	12 ms				
	Max.	34 ms	68 ms	68 ms				
Excl. of Access		0.3 ms	0.3 ms	10 ms				

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic Drum	Internal	512	8	17 ms	0.6 ms	Serial	10"dia. x 2"long	3600 rpm

INPUT/OUTPUT:

Type	Function	Speed
Typewriter	In-Out	7.5 characters/second
Tape Reader	Input	7.5 characters/second
Magnetic Tape	In-Out	1.5 seconds per 64 words

TAPE SEARCH: None.
ARITHMETIC MODE: Serial. CLOCK FREQ.: 115 kc.
COMPUTING ELEMENT: Diode Gating.
COMPONENTS: 240 tubes, 2000 crystal rectifiers, 12 relays.
REMARKS:

BUILT BY: Electronic Computer Division, Underwood Corporation, N.Y., N.Y.
INSTALLATIONS:

COPIES AVAILABLE: For sale.
PROGRAMMING SERVICE: Available.
COMPUTING TIME:
FLOOR AREA: 13 sq. ft. POWER CONSUMPTION: 5 kva.
COOLING: None required. FIRST READY FOR USE:
BEST SUITED FOR: General purpose applications.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 10 (excess-3 representation).
WORD LENGTH: 8 decimal digits and sign.
NUMBER RANGE: 10^{-8}-1 to 1-10^{-8}. INSTRUCTION TYPE: Two address
NEGATIVE NO. REP.: Abs. value & sign. SEQUENCE CONTROL: General store.
OPERATIONS: All basic arithmetic operations, shift-extract, normalize, tally, store, transfer, input-output, tape search.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	1.5 ms	17 ms	17 ms	17 ms			
	Max.	34 ms	51 ms	68 ms	68 ms			
Excl. of Access		0.3 ms	0.3 ms	12 ms.av.	12 ms.av.			

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic Drum	Internal	1000	20	17 ms	0.6 ms	Serial	10"dia. x 5"long	3600 rpm
Magnetic Tape	External	125,000	5	800 sec	1.65 sec	Ser.-Par.	1200 ft.	27"/sec.

INPUT/OUTPUT:

Type	Function	Speed
Typewriter	In-Out	10 char/sec
Punched tape	In-Out	10 char/sec
Magnetic Tape	In-Out	1.6 sec. per 50 words

TAPE SEARCH: Possible in either direction.
ARITHMETIC MODE: Serial. CLOCK FREQ.: 105 kc.
COMPUTING ELEMENT: Diode gating.
COMPONENTS: 350 tubes, 4000 crystal rectifiers, 35 relays.
REMARKS: The computer utilizes automatic odd-even check and number-of-characters-per-block check on tape read. Check of 0000 and 1111.

BUILT BY: Electronic Computer Division, Underwood Corporation, New York, N.Y.
INSTALLATIONS: Office of Chief of Ordnance, U. S. Army., Washington, D.C.

COPIES AVAILABLE:
PROGRAMMING SERVICE: Not available.
COMPUTING TIME: Not available.
FLOOR AREA: 85 sq. ft. POWER CONSUMPTION: 7.5 kva.
COOLING: FIRST READY FOR USE: June 1953.
BEST SUITED FOR: General numerical computation--Ordnance supply control studies.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 10 (excess-3).
WORD LENGTH: 8 decimal digits plus sign (Instructions consists of two words each.)
NUMBER RANGE: 10^{-8}-1 to 1-10^{-8}. INSTRUCTION TYPE: Three-address.
NEGATIVE NO. REP.: Abs. value & sign. SEQUENCE CONTROL: General store.
OPERATIONS: Arithmetic operations including special vector operation, square root, input-output, shift and extract, conditional transfer.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	2 ms	34 ms	34 ms	34 ms			
	Max.	68 ms	136 ms	170 ms	170 ms			
Excl. of Access		0-3 ms	0-3 ms	12 ms.Av.	12 ms. Av.			

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic Drum	Internal	10,000	100	34 ms	6 ms	Serial	18"dia. x 12"long	1800 rpm

INPUT/OUTPUT:

Type	Function	Speed
Card Reader	Input	100 cards/min.
Card Punch	Output	100 cards/min.

TAPE SEARCH:
ARITHMETIC MODE: Serial CLOCK FREQ.: 108 kc.
COMPUTING ELEMENT: Diode gating.
COMPONENTS: 500 tubes, 4500 crystal rectifiers, 120 relays.
REMARKS: Decimal digits are automatically tested for forbidden codes. The drum-channel-selecting relays are checked.

BUILT BY: Elliott Brothers Ltd., London, England

INSTALLATIONS:

(The computer was developed under the auspices of the National Research Development Corp.)

COPIES AVAILABLE:

PROGRAMMING SERVICE:

COMPUTING TIME: Available.

FLOOR AREA: 13ft. x 2 ft. POWER CONSUMPTION: 5 kw.

COOLING: Self-contained. FIRST READY FOR USE: July 1953.

BEST SUITED FOR: General purpose.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2.

WORD LENGTH: 32 binary digits.

NUMBER RANGE: -1 to 1. INSTRUCTION TYPE: Two-address.

NEGATIVE NO. REP.: Twos' complement. SEQUENCE CONTROL: General store.

OPERATIONS: Add, subtract, multiply, multiple transfer, shift, input, output, collate, round off, add and shift.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	0.2 ms	0.2 ms	7-10 ms				
	Max.	13.2 ms	13.2 ms					
Excl. of Access		0.1 ms	0.1 ms					

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic disk	Internal	1024	8	13ms		Serial	9" dia.	4500rpm
	Extendable to 3096			14 ms av.		with relay selection.		
Magnetostrictive delay lines	Internal	5	5	0	0	Serial		

INPUT/OUTPUT:

Type	Function	Speed
Photoelectric tape reader	Input	40 lines/second
Typewriter	Output	10 characters/second

TAPE SEARCH: None.

ARITHMETIC MODE: Serial. CLOCK FREQ.: 333 kc.

COMPUTING ELEMENT: Crystal-diode gates.

COMPONENTS: 500 tubes, 2500 crystals.

REMARKS: The magnetostrictive delay lines are used for the arithmetic and instruction registers. The computer is made up of 168 packaged units, of which three types account for 102.

ENIAC
(Electronic Numerical Integrator and Automatic Computer)

BUILT BY: Moore School, University of Pennsylvania
INSTALLATIONS: Ballistic Research Laboratories, Aberdeen Proving Ground, Maryland (Owned by Ordnance Corps, U. S. Army.)

COPIES AVAILABLE: No.
PROGRAMMING SERVICE:
COMPUTING TIME: Available to groups engaged in National Defense work.
FLOOR AREA: 1800 sq. ft. POWER CONSUMPTION: 200 kw.
COOLING: Large blowers. FIRST READY FOR USE: Summer 1947.
BEST SUITED FOR: Ballistic calculations; computing firing tables; general purpose.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk	8	4.5	81.5	6	35.6	3.7	139.3
Percent	5.8	3.2	58.5	4.3	25.6	2.6	100

PERSONNEL: 11 maintenance men, 13 mathematicians.

NUMBER BASE: 10 (true decimal).
WORD LENGTH: 10 decimal digits.
NUMBER RANGE: $10^{-10}-1$ to $1-10^{-10}$. INSTRUCTION TYPE:
NEGATIVE NO. REP.: Tens' complements. SEQUENCE CONTROL: Plugboard and/or IBM cards.
OPERATIONS: Add, subtract, multiply, divide, and others.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	200 μs	200 μs	2.8 ms				
	Max.	200 μs	200 μs	2.8 ms				
Excl. of Access		200 μs	200 μs	2.8 ms				

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Electronic Registers	Internal	20						

INPUT/OUTPUT:

Type	Function	Speed
Many 10-Pos. Switches	Input	
IBM Cards	Input and output	

TAPE SEARCH:
ARITHMETIC MODE: Parallel. CLOCK FREQ.: 100 kc.
COMPUTING ELEMENT:
COMPONENTS: About 18,000 tubes.
REMARKS: ENIAC is conceptually similar to counter-wheel calculators. It has 20 electronic registers; all can add, and subtract. Decimal digits are transferred in parallel, each as a train of from 0 to 9 pulses. Operating schedule figures are based on 1952 experience.

BUILT BY: Engineering Research Associates, Division of Remington Rand, Inc., St. Paul, Minn., and Arlington, Va.
INSTALLATIONS: U. S. Government (2).
Engineering Research Associates Computation Center, Arlington, Va.

COPIES AVAILABLE: For sale.
PROGRAMMING SERVICE: Available.
COMPUTING TIME: Available.
FLOOR AREA: 110 sq. ft. POWER CONSUMPTION: 13.5 kw.
COOLING: Integrally included. FIRST READY FOR USE: December 1950 (Commerical model - 3rd quarter 1953).
BEST SUITED FOR: General large-scale computation.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING				
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair	Idle	Total
Hrs/Wk	13	0	117	-	3	0	133
Percent	10	0	88	-	2	0	100

PERSONNEL:

NUMBER BASE: 2 (8 externally).
WORD LENGTH: 24 binary digits.
NUMBER RANGE: $1-2^{23}$ to $2^{23}-1$. INSTRUCTION TYPE: One-address.
NEGATIVE NO. REP.: Ones' complement. SEQUENCE CONTROL: General store.
OPERATIONS: General arithmetic and logical operations including multiplication, division, multiple shift, input, output.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	32 μs	96 μs	352 μs	416 μs			
	Max.	See Remarks						
Excl. of Access		2.5 μs	5 μs	260 μs	324 μs			

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic Drum	Internal	16,384	192	17 ms	32 μs	Parallel	8½" dia. x 14" long	3450 rpm

INPUT/OUTPUT:

Type	Function	Speed
Photoelectric Tape Reader	Input	35 words/sec.
Electric Typewriter	Output	10 char./sec.
Tape Punch	Output	60 char./sec.

TAPE SEARCH: Not available.
ARITHMETIC MODE: Parallel. CLOCK FREQ.: 400 kc.
COMPUTING ELEMENT: Flip-flop.
COMPONENTS: 2695 tubes, 2385 crystal rectifiers, 135 relays.
REMARKS: Although drum period is 17 ms., minimum-access programming techniques normally used result in the execution of a number of instructions per drum revolution. Marginal checking plus diagnostic programs are used for maintenance.

BUILT BY: Engineering Research Associates, Division of Remington Rand, Inc., St. Paul, Minn., and Arlington, Va.

INSTALLATIONS: Arnold Engineering Development Center, Tullahoma, Tenn. (3 1102's). (Owned by Air Materiel Command, Wright Patterson Air Force Base, Ohio.)

COPIES AVAILABLE: For sale.

PROGRAMMING SERVICE: Available at ERA.

COMPUTING TIME:

FLOOR AREA: 110 sq. ft. POWER CONSUMPTION: 20 kw.

COOLING: Integrally included. FIRST READY FOR USE: 4th quarter 1953.

BEST SUITED FOR: General-purpose computation--on-line data reduction.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2

WORD LENGTH: 24 binary digits.

NUMBER RANGE: $1-2^{23}$ to $2^{23}-1$. INSTRUCTION TYPE: One-address.

NEGATIVE NO. REP.: Ones' complement. SEQUENCE CONTROL: General store.

OPERATIONS: General arithmetic and logical operations including multiplication, division, scale factor, multiple shift, operations related to input-output.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	18 μs	24 μs	92 μs	334 μs			
	Max.	See Remarks						
Excl. of Access		14 μs	16 μs	76-284 μs	318 μs			

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic Drum	Internal	4096	96	8.5 ms	2 μs	Parallel	4½" dia. x 8" long	6900 rpm

INPUT/OUTPUT:

Type	Function	Speed
Photoelectric Tape Reader	Input	50 words/second
Electric Typewriter	Output	10 characters/second
Tape Punch	Output	60 characters/second
Function Plotters	Output	

TAPE SEARCH:

ARITHMETIC MODE: Parallel. CLOCK FREQ.: 500 kc.

COMPUTING ELEMENT: Flip-flop.

COMPONENTS: 2200 tubes, 3000 crystal rectifiers, 90 relays.

REMARKS: Although the drum revolution period is 8.5 ms., minimum-access programming techniques normally used result in the execution of a number of instructions per drum revolution. Marginal checking plus diagnostic programs are used for maintenance. Multiplication and division overflow alarms are incorporated.

BUILT BY: Engineering Research Associates, Division of Remington Rand, Inc.,
INSTALLATIONS: U. S. Government. St. Paul, Minn., and Arlington, Va.

COPIES AVAILABLE: For sale or rent.
PROGRAMMING SERVICE: Available at ERA.
COMPUTING TIME:
FLOOR AREA: 300 sq. ft. POWER CONSUMPTION: 45 kw.
COOLING: Built-in. FIRST READY FOR USE: September 1953 (Commercial model - 1st quarter 1954).
BEST SUITED FOR: General large-scale computation; real-time control & simulation.
OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2
WORD LENGTH: 36 binary digits.
NUMBER RANGE: $1-2^{35}$ to $2^{35}-1$. INSTRUCTION TYPE: Two-address.
NEGATIVE NO. REP.: Ones' complement SEQUENCE CONTROL: General store.
OPERATIONS: General arithmetic and logical operations including multiplication, division, scale factor, multiple shift, repetition, memory search (both threshold and equality), and operations relating to input-output.

SPEED:		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	42 μs	48 μs	126 μs	480 μs			
	Max.	See Remarks						
Excl. of Access		18 μs	24 μs	102-402 μs	464-482 μs			

STORAGE: Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic Drum	Internal	16,384	144	34 ms	4 μs	Parallel	17"dia.	1725 rpm
							x 10"long	
Electrostatic	Internal	1024	36	10 μs	6 μs	Parallel	Spec.5"	
Magnetic Tape	External	200,000	4 units			Ser.-Par.	½"tape	45"/sec.

INPUT/OUTPUT:

Type	Function	Speed
Photoelectric Tape Reader	Input	24 words/sec.
Electric Typewriter	Output	10 char/sec.
Tape Punch	Output	60 char/sec.
Other Equipment Optional		

TAPE SEARCH: Possible in both directions. Tape positioned, read, written under program control.
ARITHMETIC MODE: Parallel. CLOCK FREQ.: 500 kc.
COMPUTING ELEMENT: Flip-flop.
COMPONENTS: 4500 tubes, 6000 crystal rectifiers, 150 relays.
REMARKS: Although the drum revolution period is 34 ms., minimum-access programming techniques normally used result in the execution of a number of instructions per drum revolution. Marginal checking plus diagnostic programs are used for maintenance. Multiplication and division overflow alarms are incorporated.

FLAC
(Florida Automatic Computer)

BUILT BY: Air Force Missile Test Center, Patrick Air Force Base, Cocoa, Fla.
INSTALLATIONS: Air Force Missile Test Center.

COPIES AVAILABLE: Copies will be available for sale.
PROGRAMMING SERVICE: Limited time and programming service are available to Air
COMPUTING TIME: Force contractors.
FLOOR AREA: 400 sq. ft. POWER CONSUMPTION: 8 kw.
COOLING: Integral. FIRST READY FOR USE: April 1953.
BEST SUITED FOR: General-purpose scientific computation.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING				
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair	Idle	Total
Hrs/Wk	4	16	20			128	168
Percent							

PERSONNEL: 4 operator-maintenance men, 4 mathematicians.

NUMBER BASE: 2 (10 externally).
WORD LENGTH: 44 binary digits and sign.
NUMBER RANGE: INSTRUCTION TYPE: Three-address
NEGATIVE NO. REP.: Abs. value & sign. SEQUENCE CONTROL: General store.
OPERATIONS: Add, subtract, multiply (rounded and unrounded, high and low order), divide (remainder available), shift, power extract, logical transfer, comparisons, complete decimal-binary and binary-decimal conversion, file.

SPEED:

		Transfer	Addition	Multiplication	Division	Dec.-Bin	Bin.-Dec.	
Incl. Access	Min.		0.2 ms	2.5 ms	2.5 ms	3.0 ms	0.8 ms	
	Max.		1.6 ms	3.0 ms	3.0 ms	4.0 ms	2.2 ms	
Excl. of Access			50 μs	2.2 ms	2.2 ms	2.8 ms	0.6 ms	

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Mercury Delay Line	Internal	512	64	384 μs	48 μs	Serial		
Magnetic Tape	External	500,000	6			Ser.-Par.		60 and 200"/sec.

INPUT/OUTPUT:

Type	Function	Speed
Magnetic Tape (reels)	In-Out	Full speed in 0.3 or 5 ms from rest.
Magnetic Tape (cartridges)	In-Out	Dumpers - 30"/sec.

TAPE SEARCH: Possible in both directions.
ARITHMETIC MODE: Serial. CLOCK FREQ.: 1 mc.
COMPUTING ELEMENT: Dynamic flip-flop with diode current gating.
COMPONENTS: 800 tubes, 15,000 crystals, 30 relays.
REMARKS: Addresses may either be absolute, relative to control counter, or relative to special register. Odd-even checking is used on the external memories. The acoustic storage can be octupled in size. This computer is similar to SEAC, DYSEAC, and MIDAC.

G 1
(Göttingen)

BUILT BY: Arbeitsgruppe Numerische Rechenmaschinen, in cooperation with the
INSTALLATIONS: Abteilung für Astrophysik, Max-Planck-Institut für Physik.

Max-Planck-Institut fürPhysik, Göttingen, Germany.
(The development of the computer was supported by the Max-Planck-Gesellschaft, Göttingen, and by ERP grants.)

COPIES AVAILABLE: No.
PROGRAMMING SERVICE:
COMPUTING TIME:
FLOOR AREA: 125 sq. ft. POWER CONSUMPTION: 2.4 kw.
COOLING: None. FIRST READY FOR USE: June 1952.
BEST SUITED FOR: Numerical integration and other repetitive calculations.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk	5		70 - 75		10 - 15		90
Percent							

PERSONNEL: 2 operators, 2 mathematicians, 1 part-time maintenance man.

NUMBER BASE: 2 (10 externally).
WORD LENGTH: 32 binary digits.
NUMBER RANGE: -8 to 8. INSTRUCTION TYPE: One-address.
NEGATIVE NO. REP.: Abs.val.&sign in store SEQUENCE CONTROL: Punched paper tape.
OPERATIONS: Addition, subtraction, multiplication, division, square root.

SPEED:

		Transfer	Addition	Multiplication	Division	Sq.Root		
Incl. Access	Min.		280 ms	450 ms	450 ms	600 ms		
	Max.		420 ms	590 ms	590 ms	600 ms		
Excl. of Access			5 ms	320 ms	320 ms	400 ms		

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time		Mode	Drum Diam., Length or CRT Type	Speed of Motion
				Max.	Min.			
Magnetic drum	Internal	36	9	20 ms	20 ms	Serial	$3\frac{1}{2}$" dia. 8" long	3000 rpm

INPUT/OUTPUT:

Type	Function	Speed
4 punched-tape readers	Input	7 digits per second
Tape punch	Output	8 digits per second
Typewriter	In&out	8 digits per second

TAPE SEARCH: None.
ARITHMETIC MODE: Serial. CLOCK FREQ.: 7.2 kc.
COMPUTING ELEMENT: Gates and flip-flops.
COMPONENTS: 476 tubes, 101 relays.
REMARKS: Negative numbers are represented by complements in the arithmetic unit. For short descriptions of the G1, see L. Biermann, H. Billing, A. Schlüter, Hopmann, ZAMM 33, 48-60 (1953) and L. Biermann and H. Billing, Naturwiss. Heft 1, 7-13 (1953).

G 2
(Göttingen)

BUILT BY: Arbeitsgruppe Numerische Rechenmaschinen, in cooperation with the
INSTALLATIONS: Abteilung für Astrophysik, Max-Planck-Institut für Physik.

Max-Planck-Institut für Physik, Göttingen, Germany.
(The development of the computer was supported by the Max-Planck-Gesellschaft, Göttingen, and by ERP grants.)

COPIES AVAILABLE: No.
PROGRAMMING SERVICE:
COMPUTING TIME:
FLOOR AREA: 200 sq. ft. POWER CONSUMPTION: 5 kw.
COOLING: None. FIRST READY FOR USE: Spring 1954
BEST SUITED FOR: General purpose; numerical analysis and algebra.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2 (10 externally).
WORD LENGTH: 50 binary digits (instructions 18 binary digits, two per word).
NUMBER RANGE: -8 to 8. INSTRUCTION TYPE: One-address.
NEGATIVE NO. REP.: Abs.val.&sign in store SEQUENCE CONTROL: General store.
OPERATIONS: Addition, subtraction, multiplication, division.

SPEED:		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.		20 ms	80 ms	80 ms			
	Max.		20 ms	80 ms	80 ms			
Excl. of Access			0.6 ms	60 ms	60 ms			

STORAGE: Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic drum	Internal	2048	64	20 ms	20 ms	Serial	12"dia. 12" long	3000rpm

INPUT/OUTPUT:

Type	Function	Speed
Teleprinter & tape punch	In & Out	7 digits per second.

TAPE SEARCH: None.
ARITHMETIC MODE: Serial. CLOCK FREQ.: 92 kc.
COMPUTING ELEMENT: Gates and flip-flops.
COMPONENTS: About 1100 tubes.
REMARKS: While one order is being executed, the next order is being read from the drum.

BUILT BY: Compagnie des Machines BULL, Paris, France.
INSTALLATIONS:

COPIES AVAILABLE: For sale and for rent.
PROGRAMMING SERVICE: Available.
COMPUTING TIME: Available.
FLOOR AREA: 2 ft x 4½ ft. POWER CONSUMPTION: 3 kw.
COOLING: None. FIRST READY FOR USE: October 1952.
BEST SUITED FOR: Accounting & math. problems requiring limited fast storage cap.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING				
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair	Idle	Total
Hrs/Wk	1.2		38.8				40
Percent	3		97				100%

PERSONNEL: 1 operator, ½ maintenance man.

NUMBER BASE: 10 (8,4,2,1 representation).
WORD LENGTH: 12 decimal digits, splittable (instructions 16 binary digits).
NUMBER RANGE: Variable decimal pt. INSTRUCTION TYPE: One-address.
NEGATIVE NO. REP.: Magnitude and sign. SEQUENCE CONTROL: Plugboard &/or punched cards.
OPERATIONS: Addition, subtraction, multiplication, division, comparison, transfer-reset.

SPEED:

		Transfer	Addition	Multiplication	Division	Comparison		
Incl. Access	Min.	0.85 ms	0.85 ms	11 ms av.	11 ms av.	0.85 ms		
	Max.	2.9 ms	2.9 ms	21 ms	21 ms	2.9 ms		
Excl. of Access		0.17 ms	0.17 ms	11/21 ms	11/21 ms	0.17 ms		

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Electromagnetic delay lines	Internal	4 to 31		.17 ms	.17ms	Serial		
Electromechanical counters	External	10		400 ms	1.4ms	Parallel		

INPUT/OUTPUT:

Type	Function	Speed
Punched cards (80 columns)	In& Out	150 cards per minute
Line printer (92 characters)	Output	150 lines per minute

TAPE SEARCH: None.
ARITHMETIC MODE: Serial. CLOCK FREQ.: 280 kc.
COMPUTING ELEMENT: Gates.
COMPONENTS: 400 tubes, 7000 crystal rectifiers, and 200 relays.
REMARKS: Provision for marginal checking is incorporated. GAMMA 3 is intended to be connected to standard 80-column punched-card machines.

Harvard Mark I
(Automatic Sequence Controlled Calculator)

BUILT BY: IBM and Harvard University
INSTALLATIONS: Harvard University, Cambridge, Mass.
(Financial support to development contributed by IBM and the U. S. Navy.)

COPIES AVAILABLE: No.
PROGRAMMING SERVICE: Available through U. S. Air Force (Wright Field).
COMPUTING TIME: Available through U. S. Air Force (Wright Field).
FLOOR AREA: 240 sq. ft. POWER CONSUMPTION: 25 kw.
COOLING: Fan; room air conditioned. FIRST READY FOR USE: 1944.
BEST SUITED FOR: Routine computation of tables; general purpose.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING				
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair	Idle	Total
Hrs/Wk	8	0	110	10		0	128
Percent	6	0	86	8		0	100

PERSONNEL: 3 operators, 1 maintenance man, 2 mathematicians, ½ clerk.

NUMBER BASE: 10 (true decimal).
WORD LENGTH: 24 decimal digits (instructions 24 binary digits).
NUMBER RANGE: Variable. INSTRUCTION TYPE: Two-address.
NEGATIVE NO. REP.: Nines' complement. SEQUENCE CONTROL: Paper tape.
OPERATIONS: Add, multiply, divide, shift, choice.

SPEED:		Transfer	Addition	Multiplication	Division	Punch	Print	
Incl. Access	Min.							
	Max.							
Excl. of Access		0.3 sec.	0.3 sec.	7 sec.	60 sec.	3 sec.	3 sec.	

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Counters	Internal	72		0.3sec	0.3sec	Parallel		
Punched Cards	External			3 sec	0.3sec	Parallel		
Punched Tape	External	5000			0.3sec	Parallel		

INPUT/OUTPUT:

Type	Function	Speed
Punched Cards	Input	200 words/minute
Punched Cards	Output	20 words/minute
Typewriter	Output	20 words/minute
Punched Tape	Input	

TAPE SEARCH: Possible in both directions.
ARITHMETIC MODE: Parallel. CLOCK FREQ.:
COMPUTING ELEMENT: Ten-position, wheels.
COMPONENTS: No tubes, no crystals, many relays.
REMARKS: The 72 storage counters are all additive. Addition and transfer can occur during multiplication, as the multiplier is an independent unit. The decimal point may be placed anywhere in word.

Harvard Mark II
(Aiken Relay Calculator)

BUILT BY: Computation Laboratory, Harvard University
INSTALLATIONS: Naval Proving Ground, Dahlgren, Virginia
(Owned by Bureau of Ordnance, U.S. Navy.)

COPIES AVAILABLE: Not available.
PROGRAMMING SERVICE: To government agencies or contractors if approved.
COMPUTING TIME: To government agencies or contractors if approved.
FLOOR AREA: 50' x 60'. POWER CONSUMPTION: 2.5 kw.
COOLING: Rm. air-conditioned FIRST READY FOR USE: September 1948
BEST SUITED FOR: Ballistic trajectory calculations.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk			102		18		120
Percent			85		15		100

PERSONNEL: 11 operators and maintenance, 5 mathematicians.

NUMBER BASE: 10 (8-4-2-1).
WORD LENGTH: 10 decimal digit, sign bit, and 5 exponent bits (instr. 6 octal digits).
NUMBER RANGE: Variable. INSTRUCTION TYPE: One-address.
NEGATIVE NO. REP.: Sign plus abs. value. SEQUENCE CONTROL: Paper tape.
OPERATIONS: Arithmetic operations plus searching and punched tape input-output orders. Division must be programmed.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	67 ms	200 ms	750 ms	5 sec.			
	Max.		200 ms	750 ms				
Excl. of Access			200 ms	750 ms				

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Relay	Internal	100		33 ms	33 ms	Parallel		
Paper Tape	External				1.6sec	Serial		

INPUT/OUTPUT:

Type	Function	Speed
Paper Tape (4 units)	Input	2½ words/sec.
Paper Tape (4 units)	Output	2½ words/sec.
Printer (4 units)	Output	2½ words/sec.

TAPE SEARCH: Possible in both directions.
ARITHMETIC MODE: Parallel. CLOCK FREQ.:
COMPUTING ELEMENT: Relays.
COMPONENTS: 13,000 relays
REMARKS: Number range from 1.0 to 9.999 999 999 with a multiplier of 10^k, where k ranges from -15 to 15. Adders and multipliers are separate, and may operate simultaneously. Complete automatic checking is accomplished by duplicate equipment.

BUILT BY: Computation Laboratory, Harvard University
INSTALLATIONS: Naval Proving Ground, Dahlgren, Virginia
(Owned by Bureau of Ordnance, U. S. Navy.)

COPIES AVAILABLE: Not available.
PROGRAMMING SERVICE: Available to government agencies and contractors.
COMPUTING TIME: Available to government agencies and contractors.
FLOOR AREA: 40' x 40'. POWER CONSUMPTION: 40 kw.
COOLING: Portable fans, room air conditioned. FIRST READY FOR USE: 1 January 1951.
BEST SUITED FOR: Problems requiring large internal storage.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk	8	8	94	18	8		136
Percent	6	6	69	13	6		100

PERSONNEL: 17 operators and maintenance men, 6 mathematicians, 5 clerical.

NUMBER BASE: 10 (2^*, 4, 2, 1 representation).
WORD LENGTH: 16 decimal digits and sign (instructions are 16 hexadecimal digits).
NUMBER RANGE: Variable dec. point. INSTRUCTION TYPE: Three-address.
NEGATIVE NO. REP.: Sign & abs. value. SEQUENCE CONTROL: Special store, but some alteration of instructions is possible.
OPERATIONS: Arithmetic operations, sequencing, input-output. Division is accomplished by computing a reciprocal.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	5 ms	5 ms	13 ms	100 ms			
	Max.	5 ms	5 ms	13 ms	100 ms			
Excl. of Access		0.8 ms	0.8 ms	10 ms				

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic Drum	Internal	200	80	4.5 ms		Ser.-Par.	8"dia.	7000 rpm
Magnetic Drums	Internal	4000	1600	5 ms		Ser.-Par.	8"dia.	7000 rpm

INPUT/OUTPUT:

Type	Function	Speed
Magnetic Tape	In-Out	5 words/sec.

TAPE SEARCH: Tape used for read-in or write-out.
ARITHMETIC MODE: Serio-Parallel CLOCK FREQ.: 28 kc.
COMPUTING ELEMENT: Flip-flop
COMPONENTS: 5000 tubes, 1300 crystal diodes, 1500 relays.
REMARKS: Information is recorded in duplicate on the tape.

Harvard Mark IV
(Harvard Magnetic Drum Calculator)

BUILT BY: Computation Laboratory, Harvard University Mass.

INSTALLATIONS: Harvard University (development supported by USAF), Cambridge,/ Technische Hochschule, Darmstadt, Germany (The Darmstadt machine is being built by the Technische Hochschule.)

COPIES AVAILABLE: No.

PROGRAMMING SERVICE: Available through USAF (Wright Field)

COMPUTING TIME: Available through USAF (Wright Field)

FLOOR AREA: 30ft x 10ft POWER CONSUMPTION: Approx. 25 kw

COOLING: Fan; room air-cond. FIRST READY FOR USE: 1952

BEST SUITED FOR: General purpose

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent			80	20			100

PERSONNEL: Approx. 3 operators, 5 maintenance men, 5 mathematicians, ½ clerical.

NUMBER BASE: 10 (modified 7,4,2,1 representation)

WORD LENGTH: 16 decimal digits and sign (instructions 8 decimal digits)

NUMBER RANGE: Decimal pt. variable INSTRUCTION TYPE: One-address

NEGATIVE NO. REP.: Abs. value and sign SEQUENCE CONTROL: Special drum store

OPERATIONS: Add, multiply, divide, shift, choice, input, output.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	2 ms	3 ms	10 ms	22 ms			
	Max.	2 ms	3 ms	10 ms	22 ms			
Excl. of Access			1 ms	8 ms	20 ms			

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic tape	External	12 tapes	4		20ms	ser-par	5/8"wi.	100in/sec
Magnetic drum	Internal	4000 no.	140	27ms	2ms	ser-par	30"	1800rpm
		10000 instr.						
Magnetic-core shifting registers	Internal	230 no.	230x4	1ms	1ms	ser-par		

INPUT/OUTPUT:

Type	Function	Speed
Magnetic tape	In/Out	57 words per second
(Each tape can be used at any time only for input, output, or printing. Its function is controlled manually.)		

TAPE SEARCH: Possible in forward direction only.

ARITHMETIC MODE: Serio-parallel CLOCK FREQ.: 16 kc

COMPUTING ELEMENT: Selenium rectifier networks

COMPONENTS: 4000 tubes, many crystal rectifiers.

REMARKS: The computer can alter addresses and jump instructions only. The adder, multiplier, and divider are separate and operate simultaneously. There is a check against forbidden digits, and there is elaborate checking in printing. Information is recorded twice on the tapes to assure accuracy.

BUILT BY: Atomic Energy Research Establishment, Harwell, England
INSTALLATIONS: Atomic Energy Research Establishment, Harwell, England

COPIES AVAILABLE:
PROGRAMMING SERVICE:
COMPUTING TIME:
FLOOR AREA: POWER CONSUMPTION:
COOLING: FIRST READY FOR USE: May 1952.
BEST SUITED FOR:

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk			92½		4		
Percent							

PERSONNEL:

NUMBER BASE: 10.
WORD LENGTH: 8 decimal digits (instructions 5 decimal digits).
NUMBER RANGE: -10 to 10. INSTRUCTION TYPE: Two-address.
NEGATIVE NO. REP.: SEQUENCE CONTROL: Punched tapes.
OPERATIONS:

SPEED:		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.		2 sec	10 sec	10 sec			
	Max.		2 sec	15 sec	15 sec			
Excl. of Access			1 sec					

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Dekatron	Internal	40						

INPUT/OUTPUT:

Type	Function	Speed
7 punched tape readers	Input	1 instruction per second

TAPE SEARCH:
ARITHMETIC MODE: CLOCK FREQ.:
COMPUTING ELEMENT: Relays, double-length Dekatron accumulator.
COMPONENTS:
REMARKS: There is provision for an additional 50 words of Dekatron storage. The computer is designed for unattended operation; on encountering an error it recommences the computation, goes back a few steps, or starts the next problem.

BUILT BY: Research and Development Laboratories, Hughes Aircraft Co.,
INSTALLATIONS: U. S. Air Force Culver City, Calif.
(Financial support contributed to development by Wright Air Development Center.)

COPIES AVAILABLE: Not available
PROGRAMMING SERVICE: Not available
COMPUTING TIME: Not available
FLOOR AREA: Vol. 5 cu.ft. POWER CONSUMPTION: 1.2 kw
COOLING: 6 lb/min FIRST READY FOR USE: February 1952
BEST SUITED FOR: Calculation of real-time control problems.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL: Operation and maintenance handled by same man.

NUMBER BASE: 2
WORD LENGTH: 16 bits (instructions 17 bits)
NUMBER RANGE: -1 to 1 INSTRUCTION TYPE: One address & rel. add. of next order.
NEGATIVE NO. REP.: Abs. value & sign SEQUENCE CONTROL: General store
OPERATIONS: All arithmetic operations and transfers among memory positions, as well as a few logical choice operations.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	240 μs	600 μs	2.5 ms	2.5 ms			
	Max.	2.1 ms	2.4 ms	4.3 ms	4.3 ms			
Excl. of Access		120 μs	120 μs	1.9 ms	1.9 ms			

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time		Mode	Drum Diam., Length or CRT Type	Speed of Motion
				Max.	Min.			
Magnetic Drum	Internal	2500	39	7 ms	6 μs	Serial	4" dia.	8000 rpm

INPUT/OUTPUT:

Type	Function	Speed
Keyboard	Input	
Analogue	Input	
Analogue	Output	

TAPE SEARCH:
ARITHMETIC MODE: Serial. CLOCK FREQ.: 160 kc.
COMPUTING ELEMENT: Binary adder.
COMPONENTS: 350 tubes, 2500 crystal rectifiers.
REMARKS:

BUILT BY: International Business Machines Corporation
INSTALLATIONS: Several thousand in use.

COPIES AVAILABLE: For rent.
PROGRAMMING SERVICE: Available at IBM service bureaus.
COMPUTING TIME: Available at IBM service bureaus.
FLOOR AREA: 56" x 28". POWER CONSUMPTION: 700 watts.
COOLING: None required. FIRST READY FOR USE: 1948.
BEST SUITED FOR: Repetitive calculations each of which is a short sequence, with limited variations of that sequence.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk	Varies according to installation.						
Percent							

PERSONNEL: Varies according to installation; complete maintenance furnished by IBM.

NUMBER BASE: 10 (true decimal).
WORD LENGTH: Variable—generally 6 to 12 decimal digits.
NUMBER RANGE: Variable decimal pt. INSTRUCTION TYPE: Composed of sub-instructions.
NEGATIVE NO. REP.: Tens' complement. SEQUENCE CONTROL: Prewired on plugboard.
OPERATIONS: Addition, subtraction, multiplication, division, comparison, negative test.

SPEED:

	Transfer	Addition	Multiplication	Division			
Incl. Access ~~XXXX~~ ~~XXXX~~	1 cycle	1 cycle	1 to 2 per multiplier digit	5 to 11 cycles for 1 to 7 quotient digits	(Speed varies from 4 cycles per card at 50 cards/min. downward)		
Excl. of Access							

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Electromechanical	Internal	102-134 decimal digits						

INPUT/OUTPUT:

Type	Function	Speed
Card Reader	Input	Variable
Card Punch	Output	Variable

TAPE SEARCH:
ARITHMETIC MODE: Parallel. CLOCK FREQ.:
COMPUTING ELEMENT: Counter wheels or gear clutches controlled by relays.
COMPONENTS: Several hundred relays.
REMARKS: The storage units are basically 12 decimal digits for read-in. They may be split for 6-digit read-out. The multiplier-divisor register is 8 decimal digits long. The IBM 602A can perform parallel transfers, parallel additions and subtractions, and parallel multiplications with a common multiplier.

BUILT BY: International Business Machines Corporation
INSTALLATIONS: Over 1500 in use

COPIES AVAILABLE: For rent
PROGRAMMING SERVICE: Available at IBM service bureaus
COMPUTING TIME: Available at IBM service bureaus
FLOOR AREA: 604:53x33";521:40x26" POWER CONSUMPTION: 6.9 kva [variations
COOLING: 19000 btu/hr FIRST READY FOR USE: 1948 [limited
BEST SUITED FOR: Repetitive calculations, each of which is a short sequence with

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk	Varies according to installation						
Percent							

PERSONNEL: Varies according to installation; complete maintenance furnished by IBM

NUMBER BASE: 10 (binary coded internally)
WORD LENGTH: Variable
NUMBER RANGE: Variable INSTRUCTION TYPE: Composed of sub-instructions
NEGATIVE NO. REP.: Tens' complement/sign SEQUENCE CONTROL: Prewired on plugboard
OPERATIONS: Addition, subtraction, multiplication, division, zero test, positive or negative test, repetition, shift.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	480 μs	480 μs	2.4 ms	4.8 ms			
	Max.	480 μs	480 μs	24 ms	26.4 ms			
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Vacuum-tube regist.	Internal	50 decimal digits						

INPUT/OUTPUT:

Type	Function	Speed
Card reader	Input	100 cards/minute
Card punch	Output	100 cards/minute

TAPE SEARCH:
ARITHMETIC MODE: Parallel CLOCK FREQ.: 50 kc
COMPUTING ELEMENT: Flip-flop
COMPONENTS: 1400 tubes, 125 relays
REMARKS: The 50-digit total register capacity may be broken up in various ways to accommodate different number lengths. The decimal point is variable in position. Instructions are effectively of the two-address type. A product-overflow test, a balance test, and a double-punch blank-column test are incorporated in the computer.

BUILT BY: International Business Machines Corporation
INSTALLATIONS:

COPIES AVAILABLE: For rent.
PROGRAMMING SERVICE: Available at IBM service bureaus.
COMPUTING TIME: Available at IBM service bureaus.
FLOOR AREA: 607&942 are 53x33". 529 is 40x26". POWER CONSUMPTION:
COOLING: FIRST READY FOR USE: April 1953.
BEST SUITED FOR: Problems requiring moderate storage and computation.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk	Varies according to installation.						
Percent							

PERSONNEL: Varies according to installation; complete maintenance furnished by IBM.

NUMBER BASE: 10 (binary coded internally).
WORD LENGTH: Variable.
NUMBER RANGE: Variable. INSTRUCTION TYPE: Composed of sub-instructions.
NEGATIVE NO. REP.: Ten's complement or sign. SEQUENCE CONTROL: Prewired on plugboard.
OPERATIONS: Addition, subtraction, multiplication, division, zero test, balance test, suppression, skip, repeat.

SPEED:

		Transfer	Addition	Multiplication	Division	Suppress	Skip	
Incl. Access	Min.	520 μs	520 μs	2.4 ms	4.7 ms	80 μs	80 μs	
	Max.	520 μs	520 μs	23. ms	25.4 ms	80 μs	80 μs	
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Vacuum-tube registers	Internal	162 decimal digits						

INPUT/OUTPUT:

Type	Function	Speed
Card reader	Input	100 cards/min
Card punch	Output	100 cards/min

TAPE SEARCH:
ARITHMETIC MODE: Parallel. CLOCK FREQ.: 50 kc.
COMPUTING ELEMENT: Flip-flop.
COMPONENTS: 2000 tubes, 150 relays.
REMARKS: The word length and decimal-point position are arbitrary within the limits imposed by the register capacity. Effectively instructions are of the two-address type. A double-punch blank-column check, a balance test, and a product-overflow check are incorporated in the computer.

BUILT BY: International Business Machines Corp.
INSTALLATIONS: International Business Machines Corp.

COPIES AVAILABLE: Will be available for rent with 1000- or 2000-word memory.
PROGRAMMING SERVICE: Will be available.
COMPUTING TIME: Will be available.
FLOOR AREA: See Remarks. POWER CONSUMPTION: 16 kva.
COOLING: Internal fans. FIRST READY FOR USE: July 1954.
BEST SUITED FOR: Scientific & commercial computing, utility, billing; genral-purpose.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL: Maintenance by manufacturer.

NUMBER BASE: 10 (biquinary representation; 0 or 5 plus 0,1,2,3,or 4).
WORD LENGTH: 10 decimal digits and sign.
NUMBER RANGE: Dec.pt. arbitrary. INSTRUCTION TYPE: Two-address.
NEGATIVE NO. REP.: Abs. value & sign. SEQUENCE CONTROL: General store.
OPERATIONS: Add, subtract, multiply, divide, input, output, branching, table look-up, shift right or left, alter instruction address, normalize.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.							
	Max.	Average:	5.2 ms	11.6 ms	14.5 ms			
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic Drum	Internal	1000 or 2000	20 or 40	4.8 ms		Serio-Par	50 words	12500 rpm

INPUT/OUTPUT:

Type	Function	Speed
Card Reader	Input	200 cards per minute
Card Punch	Output	100 cards per minute
Each card can carry 10	words.	

TAPE SEARCH:
ARITHMETIC MODE: Serioparallel. CLOCK FREQ.: 125 kc.
COMPUTING ELEMENT:
COMPONENTS:
REMARKS: On the drum, the 2-out-of-5 (0,1,2,3,6) representation is used. The left and right halves of the double-length accumulator have (separate) addresses. The calculator consists of three units, the 650, the 652, and the 533. Their floor areas are, respectively, $31\frac{1}{2}$" x 78 3/4", $29\frac{1}{2}$" x 44", and 25" x 53".

IBM CPC
(Card-Programmed Electronic Calculator)

BUILT BY: International Business Machines Corporation
INSTALLATIONS: Over 150 in use.

COPIES AVAILABLE: For rent.
PROGRAMMING SERVICE: Available at IBM service bureaus.
COMPUTING TIME: Available at IBM service bureaus.
FLOOR AREA: 45 sq. ft. POWER CONSUMPTION: 10.2 kva.
COOLING: 25000 btu/hr. FIRST READY FOR USE: 1949.
BEST SUITED FOR: Lengthy sequential operations.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk	Varies according to installation						
Percent							

PERSONNEL: Varies according to installation; complete maintenance furnished by IBM.

NUMBER BASE: 10 (binary coded internally).
WORD LENGTH: 10 decimal digits and sign.
NUMBER RANGE: Variable dec. pt. INSTRUCTION TYPE: Three-address.
NEGATIVE NO. REP.: Ten's complement/sign SEQUENCE CONTROL: Program cards and plugboard.
OPERATIONS: Addition, subtraction, multiplication, division, repetition, zero test, suppression, shift, wired subroutines for power-series expansions of basic transcendental functions.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	480 μs	480 μs	2.4 ms	4.8 ms			
	Max.	480 μs	480 μs	24 ms	26.4 ms			
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Vacuum-tube registers	Internal	290 decimal digits						
Relays	Internal	16 words in each of up to three 941's.						

INPUT/OUTPUT:

Type	Function	Speed
Card reader	Input	Up to 150 cards/minute
Printer	Output	150 lines/min numeric
Printer	Output	100 lines/min alphameric

TAPE SEARCH:
ARITHMETIC MODE: Parallel. CLOCK FREQ.: 50 kc.
COMPUTING ELEMENT: Flip-flops.
COMPONENTS: 1400 tubes, 10 crystal rectifiers, 2000 relays.
REMARKS: Some simultaneous execution of different operations is possible by appropriate wiring. Double-punch blank-column check and product-overflow check are built into this computer.

ILLIAC
(Illinois Automatic Computer)

BUILT BY: University of Illinois
INSTALLATIONS: University of Illinois
(Financial support to development of ILLIAC contributed directly or indirectly by U. S. Army Ordnance Corps, Office of Naval Research, Atomic Energy Commission, U. S. Air Force.)

COPIES AVAILABLE: No.
PROGRAMMING SERVICE: No.
COMPUTING TIME: Available within the University of Illinois.
FLOOR AREA: 25 sq. ft. POWER CONSUMPTION: 35 kw.
COOLING: 3000 cu.ft. min. FIRST READY FOR USE: 1 September 1952.
BEST SUITED FOR: Computation not involving large input or output.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk	12½	10	50		7½		80
Percent	15½	12½	62½		9½		100

PERSONNEL: 1 operator, 1 maintenance man on call, 3 mathematicians.

NUMBER BASE: 2 (16 externally).
WORD LENGTH: 40 binary digits (instructions 20 binary digits).
NUMBER RANGE: -1 to $1-2^{-39}$. INSTRUCTION TYPE: One-address
NEGATIVE NO. REP.: Twos' complement. SEQUENCE CONTROL: General store.
OPERATIONS: Add, subtract, multiply, divide, absolute value, logical multiply, shift, sign-conditional transfer.

SPEED:

		Transfer	Addition	Multiplication	Division	Shift		
Incl. Access	Min.		72 μs	642 μs	772 μs			
	Max.		72 μs	822 μs				
Excl. of Access			50 μs	714 μs av.	754 μs	16 μs		

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Electrostatic (Williams tube)	Internal	1024	40	36 μs	18 μs	Parallel	3KP1	
						Read-around ratio = 25		

INPUT/OUTPUT:

Type	Function	Speed
Photoelectric Tape Reader	Input	240 characters/sec.
Tape Punch	Output	25 characters/sec.
Typewriter	Output	6.3 characters/sec.

TAPE SEARCH:
ARITHMETIC MODE: Parallel. CLOCK FREQ.: Asynchronous.
COMPUTING ELEMENT: Eccles-Jordan flip-flop "and" or "not".
COMPONENTS: 2774 tubes, no crystals, 1 relay.
REMARKS: The logical design of this computer is modeled after the IAS computer. ORDVAC is a very similar computer also built by University of Illinois.

BUILT BY: Institute for Advanced Study, Princeton, New Jersey
INSTALLATIONS: Institute for Advanced Study. For other similar computers, see AVIDAC, ILLIAC, JOHNNIAC, MANIAC, ORACLE, ORDVAC, and TC-1. (Financial support to development contributed by Office of Naval Research, Atomic Energy Commission, U. S. Air Force, and the U. S. Army Ordnance Corps.)

COPIES AVAILABLE: No.
PROGRAMMING SERVICE:
COMPUTING TIME:
FLOOR AREA: 100 sq.ft. POWER CONSUMPTION: 15 kw.
COOLING: 2000 cu.ft. min. FIRST READY FOR USE: 1 January 1952.
BEST SUITED FOR: General purpose.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk	10.0	19.8	32.2	2.8	15.2	0	80.0
Percent	12.5	24.7	40.3	3.5	19.0	0	100.0

PERSONNEL: 3 operators, 2 maintenance men.

NUMBER BASE: 2 (10 externally).
WORD LENGTH: 40 binary digits (instructions 20 binary digits).
NUMBER RANGE: -1 to $1-2^{-39}$. INSTRUCTION TYPE: One-address.
NEGATIVE NO. REP.: Twos' complement SEQUENCE CONTROL: General store.
OPERATIONS: Add, subtract, multiply, divide, shift right or left by arbitrary number n, unconditional and conditional transfers of control.

SPEED:

		Transfer	Addition	Multiplication	Division	Shift		
Incl. Access	Min.	39 μs	62 μs	435 μs	1100 μs	42 μs		
	Max.	39 μs	62 μs	990 μs	1100 μs	410 μs		
Excl. of Access			25 μs	400-955 μs	1065 μs	410 μs		

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Electrostatic (Williams tube)	Internal	1024	40	25 μs	25 μs	Parallel	5CP1A	
Magnetic Drum (being built)								

INPUT/OUTPUT:

Type	Function	Speed
Punched Card Reader	Input	1024 words in 48 sec.
Card Punch	Output	1024 words in 48 sec.

TAPE SEARCH: No tape.
ARITHMETIC MODE: Parallel. CLOCK FREQ.: Asynchronous.
COMPUTING ELEMENT: 6J6 Toggle.
COMPONENTS: 2300 tubes, no crystals, no relays.
REMARKS:

IRSIA-FNRS Computer

BUILT BY: Bell Telephone Mfg. Co., Antwerp, Belgium.

INSTALLATIONS: The Institut pour l'encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture and the Fonds Nationale de la Recherche Scientifique have supported the development of this computer.

COPIES AVAILABLE: No.

PROGRAMMING SERVICE:

COMPUTING TIME:

FLOOR AREA: 25' x 25' POWER CONSUMPTION: 4.5 kw (estimated).

COOLING: Air-conditioned/room FIRST READY FOR USE: 1954.

BEST SUITED FOR: General purpose.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 10 (four-binary-digit code).

WORD LENGTH: 17 decimal digits and sign (instructions 9 decimal digits).

NUMBER RANGE: $\pm 10^{-50}$ to $\pm 10^{50}$. INSTRUCTION TYPE: One-address.

NEGATIVE NO. REP.: Absolute value & sign SEQUENCE CONTROL: Magnetic drum.

OPERATIONS:

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.		3 ms	3 ms	Programmed:			
	Max.		3 ms	14 ms	140 ms			
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic drum	Internal	2000 nos. 4000 instr.	200	14 ms	0	Serial	12" dia. 20" long	4000 rpm
6 Magnetic tapes	External	These tapes are circular.					150 ft.	Forward

INPUT/OUTPUT:

Type	Function	Speed
Magnetic tape	In&Out	1 meter per second, 10 kc.

TAPE SEARCH: Possible in the forward direction.

ARITHMETIC MODE: Serial. CLOCK FREQ.: 100 kc.

COMPUTING ELEMENT: Rectifier matrices.

COMPONENTS: About 2000 tubes, 1000 selenium rectifiers, and 1500 germanium diodes.

REMARKS: Input and output are on two tape tracks, which are checked against each other and against the drum on each transfer. The drum is asynchronous, and relay track selection is used. The decimal point can be either fixed (variable) or floating. In the former case, numbers are 17 decimal digits long; in the latter case 2 digits are given over to the exponent.

JAINCOMP-A
(Jacobs Instrument Co. Computer)

BUILT BY: The Jacobs Instrument Co., Bethesda, Md.

INSTALLATIONS: The Jacobs Instrument Co.
(Bureau of Ordnance, U. S. Navy, has supported the development of this computer.)

COPIES AVAILABLE: Not available.

PROGRAMMING SERVICE: Not available.

COMPUTING TIME: Not available.

FLOOR AREA: 1.2 sq. ft. POWER CONSUMPTION: 450 w.

COOLING: 130 cfm. FIRST READY FOR USE: Spring 1950.

BEST SUITED FOR: Built to test principles.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2.

WORD LENGTH: 5 binary digits.

NUMBER RANGE: -15 to 15. INSTRUCTION TYPE: Two-address.

NEGATIVE NO. REP.: Sign & abs. value. SEQUENCE CONTROL: Several sequences built in.

OPERATIONS: Addition, subtraction, multiplication, sine.

SPEED:

		Transfer	Addition	Multiplication	Division	Sin		
Incl. Access	Min.	1 μs	6 μs	50 μs		250 μs		
	Max.	1 μs	15 μs	50 μs		750 μs		
Excl. of Access			3-12 μs	47 μs		250 μs		

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Vacuum tube registers	Internal	3		1 μs	1 μs	Parallel		

INPUT/OUTPUT:

Type	Function	Speed
Toggle switches	Input	Access time 1 s
Punched card	Input	Access time 1 s
Analog instruments	Input	
Neon indicators	Output	

TAPE SEARCH:

ARITHMETIC MODE: Parallel. CLOCK FREQ.: Asynchronous.

COMPUTING ELEMENT: Flip-flop.

COMPONENTS: 103 tubes, 350 crystal rectifiers.

REMARKS: This computer was built to test the feasibility of a compact, real-time computer operating in the parallel mode. Several programs are built in.

JAINCOMP-B1
(Jacobs Instrument Co. Computer)

BUILT BY: The Jacobs Instrument Co., Bethesda, Maryland.

INSTALLATIONS: The Jacobs Instrument Co.
(The U.S. Navy Bureau of Ordnance supported the development of the computer.)

COPIES AVAILABLE: For sale.

PROGRAMMING SERVICE: Not available.

COMPUTING TIME: Not available.

FLOOR AREA: 4.75 sq. ft. POWER CONSUMPTION: 2.75 kva.

COOLING: 780 cfm. FIRST READY FOR USE: Spring 1951.

BEST SUITED FOR: Real-time computation with fixed program and little input.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2.

WORD LENGTH: 24 binary digits (instructions 16 binary digits).

NUMBER RANGE: -32 to 32. INSTRUCTION TYPE: Two- or three-address.

NEGATIVE NO. REP.: Magnitude and sign. SEQUENCE CONTROL: One electronically scanned punched card.

OPERATIONS: Addition, subtraction, multiplication, division, sine, inverse sine, squaring, cubing, reverse division, reverse subtraction.

SPEED:

		Transfer	Addition	Multiplication	Division	Sin	Arcsin	
Incl. Access	Min.	$1\frac{1}{2}$ μs	18 μs	750 μs	1.6 ms	11 ms	80 ms	
	Max.	$13\frac{1}{2}$ μs	24 μs	750 μs	2.4 ms	11 ms	80 ms	
Excl. of Access		Max:	8 μs	730 μs	2.38 ms	11 ms	80 ms	

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Static magnetic cores	Internal	3		4 μs	4 μs	Parallel		
Program memory	Internal	3		1 μs	1 μs	Parallel		

INPUT/OUTPUT:

Type	Function	Speed
8 words of toggle switches	Input	Access time 1 microsecond.
32-word program punch card	Input	Access time 1 microsecond.
Neon indicators	Output	

TAPE SEARCH:

ARITHMETIC MODE: Parallel. CLOCK FREQ.: Asynchronous.

COMPUTING ELEMENT: Flip-flops.

COMPONENTS: 409 tubes, 4032 crystal rectifiers.

REMARKS:

JAINCOMP-C
(Jacobs Instrument Co. Computer)

BUILT BY: The Jacobs Instrument Co., Bethesda, Maryland.
INSTALLATIONS: The Jacobs Instrument Co.
(The U.S.Navy Bureau of Ordnance supported the development of this computer.)

COPIES AVAILABLE: No.
PROGRAMMING SERVICE: Not available.
COMPUTING TIME: Not available.
FLOOR AREA: 4.2 sq. ft. POWER CONSUMPTION: 4 kw.
COOLING: 1200 cfm. FIRST READY FOR USE: Summer 1953.
BEST SUITED FOR: Real-time or general-purpose computing.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2 (2 and 8 externally).
WORD LENGTH: 24 binary digits.
NUMBER RANGE: -16 to 16. INSTRUCTION TYPE: Three-address.
NEGATIVE NO. REP.: Magnitude and sign. SEQUENCE CONTROL: Electronically scanned punched card.
OPERATIONS: Addition, subtraction, multiplication, division, sine, cos arcsin, squaring, reverse subtraction.

SPEED:

		Transfer	Addition	Multiplication	Division	Sin	Cos sin^{-1}	
Incl. Access	Min.	1½ μs	18 μs	0.25 ms	0.90 ms	3 ms	2.5 ms	
	Max.	13½ μs	24 μs	0.65 ms	1.63 ms	5 ms	4.2 ms	
Excl. of Access		Max:	8 μs	0.63 ms	1.61 ms	5 ms	4.2 ms	

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Static magnetic cores	Internal	24		4 μs	4 μs	Parallel		
Input storage	Internal	9		4 μs	4 μs	Parallel		
Program memory	Internal	4		1 μs	1 μs	Parallel		

INPUT/OUTPUT:

Type	Function	Speed
Various instruments	In& Out	Input cycle 0.1 s., out.15 s
Toggle switches	Input	Access time 1 microsecond.
Punched card (66 numbers)	Input	Access time 1 microsecond.
Punched card (128 instrs.)	Input	Access time 1 microsecond.

TAPE SEARCH:
ARITHMETIC MODE: Parallel. CLOCK FREQ.: Asynchronous.
COMPUTING ELEMENT: Flip-flop.
COMPONENTS: 801 tubes and a large number of crystal rectifiers.
REMARKS:

JOHNNIAC
(After John von Neumann)

BUILT BY: RAND Corp., Santa Monica, California
INSTALLATIONS: RAND
(Owned by U. S. Air Force.)

COPIES AVAILABLE: No.
PROGRAMMING SERVICE: Not at present (February 1953).
COMPUTING TIME: Not at present (February 1953).
FLOOR AREA: 600 sq. ft. POWER CONSUMPTION: 30 kw.
COOLING: 10,000 cu.ft. min. FIRST READY FOR USE: January 1954.
BEST SUITED FOR: Scientific calculations for general research.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL: 1 operator, 1 maintenance man, 5 mathematicians, 1 clerk.

NUMBER BASE: 2
WORD LENGTH: 40 binary digits (instructions 19 binary digits).
NUMBER RANGE: -1 to 1-2^{-39}. INSTRUCTION TYPE: One-address.
NEGATIVE NO. REP.: Twos' complement SEQUENCE CONTROL: General store.
OPERATIONS: Add, subtract, multiply, divide, absolute magnitude, selective substitution, logical product, transfer control, hoot, display on console.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	25 μs	55 μs	425 μs	835 μs			
	Max.	25 μs	55 μs	835 μs	835 μs			
Excl. of Access			30 μs	400-810 μs	810 μs			

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Electrostatic (Selectron tubes)	Internal	256	40	25 μs	25 μs	Parallel		
Magnetic Drum	External	2048	40	25 ms	5 ms	Parallel	17"	1200rpm

INPUT/OUTPUT:

Type	Function	Speed
IBM 077 Collator	Input	96 words/sec.
IBM 517 Punch	Output	20 words/sec.

TAPE SEARCH:
ARITHMETIC MODE: Parallel. CLOCK FREQ.: Asynchronous.
COMPUTING ELEMENT: 6J6 flip-flop.
COMPONENTS: About 3000 tubes, no crystals, about 200 relays.
REMARKS: This machine is a modified IAS type computer with selectron and magnetic-drum memory.

LEO
(Lyons Electronic Office)

BUILT BY: J. Lyons & Co., Ltd., London
INSTALLATIONS: J. Lyons & Co.

COPIES AVAILABLE: No.
PROGRAMMING SERVICE: Available.
COMPUTING TIME: Available.
FLOOR AREA: 800 sq.ft. POWER CONSUMPTION: 35 kw.
COOLING: 3500 cfm. FIRST READY FOR USE: 1951.
BEST SUITED FOR: General purpose; routine commercial clerical work.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk	7	30	15	1.5	8	0	67.5
Percent	11.4	48.8	24.4	2.4	13.0	0	100%

PERSONNEL: 2 operators, 4 maintenance men, 5 programmers, 5 clerical.

NUMBER BASE: 2 (externally decimal, sterling, etc.)
WORD LENGTH: 34 or 17 binary digits and sign (instructions 17 binary digits).
NUMBER RANGE: -1 to 1. INSTRUCTION TYPE: One-address.
NEGATIVE NO. REP.: Complement. SEQUENCE CONTROL: General store.
OPERATIONS: Add, subtract, multiply, shift, "and."

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.							
	Max.	1.5 ms	1.5 ms	6.0 ms				
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Acoustic	Internal	2048 (17-digit words)	64	1.2 ms		Serial		

INPUT/OUTPUT:

Type	Function	Speed
Punched cards	In&Out	Reads 200 cpm, punches 100 cpm
Punched paper tape	In&Out	7 characters per second
Photoelectric tape readers	Input	25 & 200 rows/second
Teleprinter, Tabulator	Output	7 char/sec, 100 lines/min.

TAPE SEARCH: None.
ARITHMETIC MODE: Serial. CLOCK FREQ.: 500 kc.
COMPUTING ELEMENT:
COMPONENTS: 6000 tubes, 1500 crystal rectifiers, 120 relays.
REMARKS: LEO is patterned after EDSAC I. Marginal checking, using 50-cycle a.c. injected at numerous points, is incorporated into the computer.

BUILT BY: Engineering Research Associates, Div. of the Remington Rand Corp.
INSTALLATIONS: Logistics Research Project of George Washington University, D.C. (Owned by Office of Naval Research.)

COPIES AVAILABLE: For sale.
PROGRAMMING SERVICE: Sometimes available.
COMPUTING TIME: Available.
FLOOR AREA: 190 sq. ft. POWER CONSUMPTION: 43 kw.
COOLING: 11 tons cooling air FIRST READY FOR USE: 1 March 1953.
BEST SUITED FOR: Data handling; short simple routines repeated many times.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING				
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair	Idle	Total
Hrs/Wk	4-6	6-8	16-18	6-8	2-4	0-2	42½
Percent	10-15	15-20	40-45	15-20	5-10	0-5	100

PERSONNEL: 1 operator, 2 maintenance men, 3 mathematicians, 1 clerk, 1 in training as mathematician.

NUMBER BASE: 10 (excess-3).
WORD LENGTH: From 4 to 12 decimal digits.
NUMBER RANGE: Up to $\pm(10^{12}-1)$. INSTRUCTION TYPE: Composed of sub-instructions.
NEGATIVE NO. REP.: Nines' complement. SEQUENCE CONTROL: Wired in removable plug board.
OPERATIONS: Transfer, add, subtract, multiply, count, shift, unconditional and conditional jumps, no division.

SPEED:

		Transfer	Addition	Multiplication	Division	Count	Store on Drum	Read from Drum
Incl. Access	Min.	70 μs-4ms	130μs-4ms	1.6ms-18ms			10 ms	4 ms
	Max.	130μs-20ms	475μs-20ms	14.2-34 ms		96 μs	36 ms	30 ms
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic Drum	Internal	175000 dec.dig.	200	25ms	4ms	Ser-Par	8½x14"	3600rpm
5 Elec. registers	Internal	41 dec. dig.		130 μs	70 μs	Ser-Par.		

INPUT/OUTPUT:

Type	Function	Speed
Paper Tape (Photoread)	Input	300 digits/sec.
Magnetic Tape	Input	300 digits/sec.
Paper Tape (Punch)	Output	11 digits/sec.
Magnetic Tape	Output	300 digits/sec.

TAPE SEARCH: None.
ARITHMETIC MODE: Serio-parallel. CLOCK FREQ.: 220 kc.
COMPUTING ELEMENT: Flip-flop.
COMPONENTS: 3500 tubes, 2000 crystals, 200 relays.
REMARKS: Number length on drum variable between 4 to 12 digits, set by switch. Input and computation are concurrent. Under "Speed," the shorter times include access to the electronic registers, the longer times include access to the drum. Decimal point is variable.

MADDIDA
(Magnetic Drum Digital Differential Analyzer)

BUILT BY: Northrop Aircraft Corp., Hawthorne, California.
INSTALLATIONS: Northrop, North American, Utah University, Applied Physics Laboratory (3), Arnold Engineering, etc.

COPIES AVAILABLE: No.
PROGRAMMING SERVICE: Not available.
COMPUTING TIME: Not available.
FLOOR AREA: 10 sq. ft. POWER CONSUMPTION: 3 kw.
COOLING: Internal fan. FIRST READY FOR USE: July 1951.
BEST SUITED FOR: Solution of differential equations.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk	0	0	20	12	8	0	40
Percent	0	0	50	30	20	0	100

PERSONNEL: ½ operator, ½ maintenance man, 1 other person.

NUMBER BASE: 2 (8 externally).
WORD LENGTH: 32 binary digits (instructions 64 binary digits).
NUMBER RANGE: -1 to 1. INSTRUCTION TYPE:
NEGATIVE NO. REP.: Complement. SEQUENCE CONTROL: Special drum store.
OPERATIONS: Add, dy_m to y_m and multiply by dx_n.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	Forty-four integrations are processed in one drum revolution.						
	Max.							
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic Drum	Internal	264	6	16ms		Serial	8"	3600rpm

INPUT/OUTPUT:

Type	Function	Speed
Keyboard (2 keys, 0 & 1)	Input	slow
Ocilloscope	Output	slow

TAPE SEARCH:
ARITHMETIC MODE: Serial. CLOCK FREQ.: 100 kc.
COMPUTING ELEMENT:
COMPONENTS: 150 tubes, 1200 crystals.
REMARKS: Overflow can be used for decision if desired.

Manchester Electronic Computer

BUILT BY: Ferranti Ltd., Moston, Manchester, England

INSTALLATIONS: Manchester University, England (owned by D.S.I.R.)
University of Toronto, Canada (owned by N.R.C., called FERUT)
Ferranti Ltd., London, England
Shell, Amsterdam, The Netherlands
British Ministry of Supply (2), for Armament Research Establishment, Fort Halstead

COPIES AVAILABLE: For sale.

PROGRAMMING SERVICE: Available in England and Toronto.

COMPUTING TIME: Available in England and Toronto.

FLOOR AREA: 2 bays 16x18' & desk. POWER CONSUMPTION: 26 kw.

COOLING: 3000 cfm/3-ton a./cond. FIRST READY FOR USE: July 1951

BEST SUITED FOR: General purpose.

OPERATING SCHEDULE:

M=Manchester T=Toronto		ENGINEERING		PROBLEM SOLVING			Idle	Total
		Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
	Hrs/Wk	T15 M18	T13	M81 T40	M11 T10	T40	T50	M110 T168
	Percent	T9 M17	T7	M73 T24	M10 T6	T24	T30	100%

PERSONNEL: Manchester: 12 operator-mathematicians, 5 maintenance men, 3 administrative, 3 clerical, 3 in training on maintenance.
Toronto: 3 maintenance men, 10 mathematicians, 2 clerical.

NUMBER BASE: 2 (10 externally).

WORD LENGTH: 20 or 40 binary digits (instructions 20 binary digits).

NUMBER RANGE: Fixed binary point. INSTRUCTION TYPE: One-address.

NEGATIVE NO. REP.: Complement. SEQUENCE CONTROL: General store.

OPERATIONS: Addition, subtraction, multiplication, logical operations; no division. A "B" tube stores eight 20-binary-digit lines to which relative addresses can be referred.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	1.2 ms	1.2 ms	3.36 ms	About			
	Max.				0.1 sec			
Excl. of Access				2.16 ms	Programmed			

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Electrostatic CRT	Internal	256	8	240 μs		Serial	GEC	
Magnetic drum	External	16,384 (40-bit words)	256	30 ms		Serial	10" dia. x12"	2000rpm

INPUT/OUTPUT:

Type	Function	Speed
Photoelectric tape reader	Input	200 frames per second
Tape punch	Output	18 frames per second
Teleprinter	Output	7 characters per second
Parallel printer	Output	150 lines/min. of 64 chars.

TAPE SEARCH: Possible in the forward direction.

ARITHMETIC MODE: Serial. CLOCK FREQ.: 100 kc.

COMPUTING ELEMENT: Tubes.

COMPONENTS: 1800 pentodes, 2000 vacuum diodes.

REMARKS: The cathode-ray store holds all the digits of a word on one line of a single tube.

MANIAC

(Mathematical Analyzer, Numerical Integrator, and Computer)

BUILT BY: Los Alamos Scientific Laboratory
INSTALLATIONS: Los Alamos Scientific Laboratory

COPIES AVAILABLE: No.
PROGRAMMING SERVICE: Available in limited quantity to other AEC laboratories and for
COMPUTING TIME: certain problems of academic interest to staff.
FLOOR AREA: 20 sq.ft. POWER CONSUMPTION: 30 kw.
COOLING: 24 kw air-conditioner FIRST READY FOR USE: 1 March 1952
BEST SUITED FOR: General purpose.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							2 shifts
Percent	35 total	engin.	65 total	problem solving			100

PERSONNEL: 10 operators, 1 maintenance man, 4 mathematicians, 1 clerk.

NUMBER BASE: 2 (10 or 16 externally)
WORD LENGTH: 40 binary digits (instructions 20 binary digits).
NUMBER RANGE: -1 to $1-2^{-39}$. INSTRUCTION TYPE: One-address.
NEGATIVE NO. REP.: Twos' complement SEQUENCE CONTROL: General store.
OPERATIONS: Add, subtract, multiply, divide, logical operations, shift right and left, input, output.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	30 μs	60 μs	950 μs	950 μs			
	Max.	30 μs	60 μs	950 μs	950 μs			
Excl. of Access			45 μs	935 μs	935 μs			

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Electronic	Internal	1024	40	16 μs	8 μs	Parallel	CRT	
Magnetic Drum	External	10,000	200			Serial	8" dia.	3600 rpm
							15" long	

INPUT/OUTPUT:

Type	Function	Speed
Photoelectric Tape Reader	Input	25 words/sec.
Printer-analex	Output	25 words/sec.
Paper Tape Punch	Output	15 characters/sec.
Single Channel Tape	In-Out	25 words/sec.

TAPE SEARCH:
ARITHMETIC MODE: Parallel. CLOCK FREQ.: Asynchronous.
COMPUTING ELEMENT:
COMPONENTS: 2500 tubes, 800 crystals, no relays.
REMARKS: The logical design of this computer is modeled on the IAS computer. Testing of the electrostatic storage system is built in; automatic checking of overflow is to be installed soon.

Mark 22 Computer
(Bell Computer, Model IV)

BUILT BY: Bell Telephone Laboratories

INSTALLATIONS: Naval Research Laboratory (Radio Division III, Operational Research Branch), Washington, D.C. (Development supported by Bureau of Ordnance, U.S.Navy.)

COPIES AVAILABLE: No.

PROGRAMMING SERVICE: Not available.

COMPUTING TIME: Not available.

FLOOR AREA: 42 sq. ft. POWER CONSUMPTION: 3 kw.

COOLING: Air-conditioned/room FIRST READY FOR USE: March 1945.

BEST SUITED FOR: Ordnance problems.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							168
Percent	0	0	87	Negligible	3	10	100

PERSONNEL: 1 Operator, 1 maintenance man, 2 mathematicians.

NUMBER BASE: 10 (biquinary).

WORD LENGTH: 5 or 6 decimal digits (instructions 2 digits).

NUMBER RANGE: -99999 to 99999. INSTRUCTION TYPE: Two-address.

NEGATIVE NO. REP.: Complement. SEQUENCE CONTROL: Paper tape.

OPERATIONS: Add, subtract, multiply, divide.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	0.4 sec	2.4 sec	2.6 sec	4.0 sec			
	Max.	0.4 sec	2.4 sec	2.6 sec	10.1 sec			
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Relay	Internal	10		0.4s	0.4s	Parallel		

INPUT/OUTPUT:

Type	Function	Speed
Teletype tape	In-Out	2 digits/sec.

TAPE SEARCH: Possible in both directions.

ARITHMETIC MODE: Parallel. CLOCK FREQ.: Asynchronous operation.

COMPUTING ELEMENT: Telephone relay.

COMPONENTS: No tubes, no crystals, 1200 relays.

REMARKS: Cannot alter its instructions. Logical checks are incorporated in all circuits. Machine operates attended for 50 hours and unattended 118 hours of each week. The decimal point is variable.

MIDAC
(Michigan Digital Automatic Computer)

BUILT BY: Willow Run Research Center, Ypsilanti, Michigan.
INSTALLATIONS: Willow Run Research Center.
(Constructed under the auspices of Wright Air Development Center, U. S. Air Force.)

COPIES AVAILABLE: No.
PROGRAMMING SERVICE: } Available. Write to Director, Willow Run Research Center
COMPUTING TIME: } for further information.
FLOOR AREA: 845 sq. ft. POWER CONSUMPTION: 83 kw.
COOLING: 10-ton air condit. FIRST READY FOR USE: 1 May 1953.
BEST SUITED FOR: General-purpose.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL: Planned for 40 hr./wk. operations: 1½ operators, 4 maintenance men, 12 mathematicians, 4 clerical.

NUMBER BASE: 2 (10 or 16 externally).
WORD LENGTH: 45 binary digits.
NUMBER RANGE: -1 to 1. INSTRUCTION TYPE: Three-address.
NEGATIVE NO. REP.: Abs. value & sign. SEQUENCE CONTROL: General store.
OPERATIONS: Add, subtract, 3 types of multiplication, divide, shift, power extract, logical transfer, comparison, decimal-binary and binary-decimal conversion, file.

SPEED:

		Transfer	Addition	Multiplication	Division	Shift	Conversion	(d-b or b-d)
Incl. Access	Min.		192 μs	2.3 ms	2.3 ms	240 μs	0.8 ms	
	Max.		1.5 ms	3.6 ms	3.6 ms	3.6 ms	1.8 ms	
Excl. of Access			48 μs	2.1 ms	2.1 ms	48-2112 μs	576 μs	

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Mercury Delay Line	Internal	512	64	384 μs		Serial	24" long	
Magnetic Drum	Internal	6144	192	42 ms	25 ms	Serial	8½" dia. 14" long	3450 rpm

INPUT/OUTPUT:

Type	Function	Speed
Flexowriter Paper Tape	In-Out	10 characters/sec.
Ferranti Photoelectric Tape Reader (planned)	Input	200 characters/sec.

TAPE SEARCH: Possible in the forward direction.
ARITHMETIC MODE: Serial. CLOCK FREQ.: 1 mc.
COMPUTING ELEMENT:
COMPONENTS: About 1100 tubes, 20,000 crystals, and 120 relays.
REMARKS: Substantial increases in the memory, input, and output are planned. MAGIC I (Michigan Automatic General Integrated Computation) is a system which automatically converts an easily-coded form of floating-address, unscaled, decimal program into machine-acceptable form. MIDAC is similar to FLAC, DYSEAC, and SEAC.

MINAC

(Minimal Automatic Computer)

BUILT BY: Digital Computing Group, California Institute of Technology

INSTALLATIONS: Digital Computing Group
(Continental Oil Co. has contributed financial support to the development of the computer.)

COPIES AVAILABLE: Not available.

PROGRAMMING SERVICE:

COMPUTING TIME:

FLOOR AREA: 1 sq. ft. POWER CONSUMPTION: 500 w.

COOLING: FIRST READY FOR USE: Summer 1953.

BEST SUITED FOR: General-purpose scientific and engineering computation

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2 (externally hexadecimal).

WORD LENGTH: 32 bits (instructions 17 bits).

NUMBER RANGE: -1 to 1 INSTRUCTION TYPE: One-address.

NEGATIVE NO. REP.: Complement. SEQUENCE CONTROL: General store.

OPERATIONS: Addition, subtraction, multiplication, division, extract, logical control orders.

SPEED:		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	2 ms	2 ms	19 ms	19 ms			
	Max.	19 ms	19 ms	36 ms	36 ms			
Excl. of Access		¼ ms	¼ ms	17 ms	17 ms			

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic Drum	Internal	8192	128	17 ms		Serial	6" dia. 8" long	3500rpm

INPUT/OUTPUT:

Type	Function	Speed
Flexowriter	In-Out	

TAPE SEARCH:

ARITHMETIC MODE: Serial. CLOCK FREQ.: 120 kc.

COMPUTING ELEMENT: Tubes and crystal diodes.

COMPONENTS: 90 tubes, 900 crystal rectifiers.

REMARKS:

BUILT BY: Marchant Research Inc. (formerly Physical Research Lab.), Oakland, California.
INSTALLATIONS: Atlantic Refining Co. (2 machines).

COPIES AVAILABLE: For sale.
PROGRAMMING SERVICE: Not available.
COMPUTING TIME: Not available.
FLOOR AREA: 16 sq. ft. POWER CONSUMPTION: 2½ kw.
COOLING: Built-in. FIRST READY FOR USE: April 1953.
BEST SUITED FOR: General purpose.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 8 and 10 (8-4-2-1 code).
WORD LENGTH: 10 decimal digit.
NUMBER RANGE: -1 to 1. INSTRUCTION TYPE:
NEGATIVE NO. REP.: Sign & abs. value. SEQUENCE CONTROL:
OPERATIONS:

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	125 μs	375 μs	6.2 ms	6.2 ms			
	Max.	10 ms	10 ms	16 ms	16 ms			
Excl. of Access		125 μs	375 μs	6.2 ms	6.2 ms			

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic Drum	Internal	4096		10 ms			6½"dia. x 10"long	6000 rpm

INPUT/OUTPUT:

Type	Function	Speed
Tape Reader	Input	10 digits/second
Tape Punch	Output	10 digits/second
Typewriter	Output	10 digits/second

TAPE SEARCH:
ARITHMETIC MODE: CLOCK FREQ.:
COMPUTING ELEMENT:
COMPONENTS:
REMARKS:

BUILT BY: MONROBOT Corp., Morris Plains, New Jersey
INSTALLATIONS: Air Force Cambridge Research Center (MONROBOT III)
Monroe Calculating Machine Co. (MONROBOT IV)
Army Engineer Corps (MONROBOT V)

COPIES AVAILABLE: For sale.
PROGRAMMING SERVICE:
COMPUTING TIME: Available in summer 1953.
FLOOR AREA: 16 sq. ft. POWER CONSUMPTION: 3 kw.
COOLING: FIRST READY FOR USE: 1 March 1953
BEST SUITED FOR: General purpose (IV), antenna design (III), mapping (V).

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING				
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair	Idle	Total
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 10 (8-4-2-1).
WORD LENGTH: 20 decimal digits (instructions 10 decimal digits).
NUMBER RANGE: -10^{10} to 10^{10} INSTRUCTION TYPE: Four-address.
NEGATIVE NO. REP.: Absolute value & sign. SEQUENCE CONTROL: Special drum store.
OPERATIONS: Add, subtract, multiply & divide, print, stop, increase an instruction address by unity, read tape, punch tape, conditional transfer, operations on absolute values.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	135 ms	135 ms	0.6 sec.	0.6 sec.			
	Max.	135 ms	135 ms	0.6 sec.	0.6 sec.			
Excl. of Access		64 ms	64 ms	0.59 sec.	0.59 sec.			

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic drum	Internal	100 Nos 200 Instr.	100	16 ms		Serial	10"dia.	3600rpm

INPUT/OUTPUT:

Type	Function	Speed
Keyboard	Input	
Flexowriter	In & Out	10 digits/sec.
Paper tape	In & Out	10 digits/sec.

TAPE SEARCH: Possible in the forward direction.
ARITHMETIC MODE: Serial. CLOCK FREQ.: 10 kc.
COMPUTING ELEMENT: Tubes.
COMPONENTS: 650 tubes, 200 crystals, 15 relays.
REMARKS: MONROBOT V is ruggedized for truck mounting, high and low temperatures (elimination of germanium diodes), shock mounted, etc.

MSAC
(Moore School Automatic Computer)

BUILT BY: Moore School, University of Pennsylvania
INSTALLATIONS: Moore School, Philadelphia, Pennsylvania
(The Signal Corps Engineering Laboratories, Fort Monmouth contributed financially to the development of the computer.)

COPIES AVAILABLE: No.
PROGRAMMING SERVICE: Available for governmand and industrial use in late 1954.
COMPUTING TIME: Available for government and industrial use in late 1954.
FLOOR AREA: 1400 sq. ft. POWER CONSUMPTION: 100 kw.
COOLING: FIRST READY FOR USE: Between July & December 1954.
BEST SUITED FOR: General purpose; small input-output problems.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING				
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair	Idle	Total
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2 (2, 8, or 16 externally).
WORD LENGTH: 44 binary digits.
NUMBER RANGE: $2^{-43}-1$ to $1-2^{-43}$. INSTRUCTION TYPE: Four-address.
NEGATIVE NO. REP.: Sign bit. SEQUENCE CONTROL: General store.
OPERATIONS: Add, substract, multiply (with, without roundoff), divide, compare, input, output.

SPEED:

		Transfer	Addition	Multiplication	Division	Compare		
Incl. Access	Min.		192 μs	2.2 ms	2.2 ms	192 μs		
	Max.		1.5 ms	3.5 ms	3.6 ms	1.2 ms		
Excl. of Access			48 μs	2.0 ms				

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Mercury Delay Lines	Internal	1024	128	384 μs		Serial	8 words	1 mc

INPUT/OUTPUT:

Type	Function	Speed
Teletype Tape		

TAPE SEARCH:
ARITHMETIC MODE: Serial. CLOCK FREQ.: 996.75 kc.
COMPUTING ELEMENT:
COMPONENTS: 3000 tubes, 20,000 crystals, 200 relays.
REMARKS: As MSAC is still under construction, many details (particularly concerning input-output) have not yet (March 1953) been frozen. Automatic checking is provided by duplicate arithmetic units working simultaneously and checking pulse for pulse.

MOSAIC
(Ministry of Supply Arithmetical Integrator & Calculator)

BUILT BY: Post Office Research Section, London, England.
INSTALLATIONS: Radar Research Establishment, Malvern, England.

COPIES AVAILABLE:
PROGRAMMING SERVICE:
COMPUTING TIME:
FLOOR AREA: Room 24'x18'. POWER CONSUMPTION: 30 kw.
COOLING: FIRST READY FOR USE: December 1952.
BEST SUITED FOR: Trial analysis.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2.
WORD LENGTH: 40 binary digits.
NUMBER RANGE: INSTRUCTION TYPE: Four-address.
NEGATIVE NO. REP.: SEQUENCE CONTROL:
OPERATIONS: Addition, subtraction, multiplication, shift, logical operations.

SPEED:		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.							
	Max.							
Excl. of Access			70 μs	6 ms				

STORAGE: Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Mercury delay line	Internal	1040		1024 μs		Serial		

INPUT/OUTPUT: Type	Function	Speed
Punched cards	In&Out	
Paper tape (4" wide)	Input	
Typewriter	Output	

TAPE SEARCH:
ARITHMETIC MODE: Serial CLOCK FREQ.: 570 kc.
COMPUTING ELEMENT: Tubes
COMPONENTS: About 6000 tubes and about 2000 crystals.
REMARKS:

NAREC
(Naval Research Laboratory Electronic Digital Computer)

BUILT BY: Naval Research Laboratory
INSTALLATIONS: Naval Research Laboratory, Washington, D. C. (Radio Division III, Operational Research Br.)

COPIES AVAILABLE: No.
PROGRAMMING SERVICE: Not available.
COMPUTING TIME: Not available.
FLOOR AREA: 100 sq. ft. POWER CONSUMPTION: 40 kw
COOLING: 15-ton air-conditioner FIRST READY FOR USE: June 1954
BEST SUITED FOR: General purpose

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2 (10 externally).
WORD LENGTH: 45 binary digits (instructions 21 binary digits)
NUMBER RANGE: -1 to 1 INSTRUCTION TYPE: One-address
NEGATIVE NO. REP.: Twos' complement SEQUENCE CONTROL: General store
OPERATIONS: Add, subtract, multiply, divide, several transfers of control, shifts, increase address contained in instruction in memory by 1.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	13 μs	22 μs	530 μs	670 μs			
	Max.	13 μs	22 μs	800 μs	800 μs			
Excl. of Access		3 μs	3 μs	520-790	660-790 μs			

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Electrostatic	Internal	1024	45	10 μs	10 μs	Parallel	3 BP1	
Magnetic drum	Internal	2048	48	16.7ms	8 μs	Parallel	12"dia., 18"long	3600rpm

INPUT/OUTPUT:

Type	Function	Speed
Magnetic tape	In.&Out	30 words/sec; 30"/sec
Paper tape	Input	20 words/sec; 20"/sec
Paper tape punch	Output	½ word/sec
Flexowriter	Output	½ word/sec

TAPE SEARCH: None.
ARITHMETIC MODE: Parallel. CLOCK FREQ.: Asynchronous.
COMPUTING ELEMENT: Vacuum tube.
COMPONENTS: 2000 tubes, 20 000 crystals, no relays.
REMARKS: First successfully operated on test problems with the magnetic-drum memory only November 1952.

NICHOLAS
(Nickel-Delay-Line-Storage Computer)

BUILT BY: Elliott Bros. Ltd., London, England
INSTALLATIONS: Elliott Bros. Ltd.

COPIES AVAILABLE:
PROGRAMMING SERVICE: Available.
COMPUTING TIME: Available.
FLOOR AREA: POWER CONSUMPTION:
COOLING: FIRST READY FOR USE: January 1953.
BEST SUITED FOR: General purpose.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2.
WORD LENGTH: 32 binary digits (instructions 16 binary digits, two per word).
NUMBER RANGE: INSTRUCTION TYPE: One-address.
NEGATIVE NO. REP.: SEQUENCE CONTROL: General store.
OPERATIONS:

SPEED:		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.					About 100 operations per second, average.		
	Max.							
Excl. of Access								

STORAGE: Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Ni magnetostrictive delay lines	Internal	1024	64	12⅓ ms	0	Serial	16 wds	
	Arith.	5	5			Serial	1 word	

INPUT/OUTPUT: Type	Function	Speed
Punched paper tape	In&Out	5-level tape is used.
Typewriter	Output	

TAPE SEARCH:
ARITHMETIC MODE: Serial. CLOCK FREQ.: 50 kc.
COMPUTING ELEMENT:
COMPONENTS:
REMARKS:

Norwegian Computer

BUILT BY: Central Institute, Royal Norwegian Council for Scientific and Industrial Research

INSTALLATIONS: Norsk Regnesentral (Norwegian Computing Centre), Oslo University, Blindern, Norway.
(U.M.M., The Board for Mathematical Machines of the Royal Norwegian Council of Scientific and Industrial Research supported the development of the computer.)

COPIES AVAILABLE: No.

PROGRAMMING SERVICE: Available to Norwegian science and industry.

COMPUTING TIME: Available to Norwegian science and industry.

FLOOR AREA: 2m x 3m. POWER CONSUMPTION: 2 kw.

COOLING: None. FIRST READY FOR USE: Fall, 1953

BEST SUITED FOR: General purpose.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2 (10 externally).

WORD LENGTH: 32 binary digits.

NUMBER RANGE: -1 to 1. INSTRUCTION TYPE: Two-address.

NEGATIVE NO. REP.: Complement. SEQUENCE CONTROL: General store.

OPERATIONS: Transfer, addition, subtraction, multiplication, sign conditional transfer of control.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	1 ms	1 ms	3 ms	Programmed			
	Max.	15 ms	15 ms	500 ms				
Excl. of Access		1 ms	1 ms					

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time		Mode	Drum Diam., Length or CRT Type	Speed of Motion
				Max.	Min.			
Magnetic drum	Internal	512	32	15 ms	1 ms	Serial	2"dia.	4000rpm
							5"long	

INPUT/OUTPUT:

Type	Function	Speed
Paper tape reader	Input	50 lines per sec.
Tape punch	Output	7 lines per sec.
Teleprinter	Output	7 characters per sec.

TAPE SEARCH: Possible in the forward direction.

ARITHMETIC MODE: Serial. CLOCK FREQ.: 40 kc.

COMPUTING ELEMENT: Electron tube.

COMPONENTS: About 450 tubes, 200 crystal rectifiers, and 10 relays.

REMARKS: This computer is a modified version of APE(X)C, built by Dr. A. D. Booth, Birkbeck College, University of London.

OARAC
(Office of Air Research Automatic Computer)

BUILT BY: General Electric Company, Syracuse, New York
INSTALLATIONS: Computation Branch, Flight Research Laboratory, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio

COPIES AVAILABLE: No.
PROGRAMMING SERVICE: Available to Air Force groups and contractors.
COMPUTING TIME: Available to Air Force groups and contractors.
FLOOR AREA: 80 sq. ft. POWER CONSUMPTION: 25 kw.
COOLING: 3000-4000 cu.ft./min FIRST READY FOR USE: 1 April 1953.
BEST SUITED FOR: General purpose.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL: 2 operators, 3 maintenance, 15 mathematicians, 2 clerical.

NUMBER BASE: 10 (2*-4-2-1).
WORD LENGTH: 10 decimal digits and sign (instructions 7 decimal digits).
NUMBER RANGE: Variable. INSTRUCTION TYPE: One-address.
NEGATIVE NO. REP.: Tens' complement. SEQUENCE CONTROL: General store.
OPERATIONS: Add, subtract, multiply, divide, choice, match, address add, normalize, clear and add, subtract absolute value, input, output.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.		400 μs	10 ms max	13 ms			
	Max.		17 ms	26 ms	30 ms			
Excl. of Access			80 μs	1-9 ms	13 ms			

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic drum	Internal	10,000	200	17 ms	240 μs	Ser.-Par.	22" dia. 30" long	3500 rpm
Magnetic tape	External	- -	5			Ser.-Par.		50"/sec.

INPUT/OUTPUT:

Type	Function	Speed
Magnetic tape	In-Out	35-45 ms/word (see above)
Keyboard	Input	7 words/minute
Typewriter	Output	10 words/minute

TAPE SEARCH: No tape search possible.
ARITHMETIC MODE: Serio-parallel. CLOCK FREQ.: 150 kc.
COMPUTING ELEMENT:
COMPONENTS: About 1400 tubes, about 7000 crystals, 240 relays.
REMARKS: An automatic redundancy check is performed on the decimal codes.

OMIBAC

BUILT BY: A. and C. S. Division, General Electric Co., Schenectady, N.Y.
INSTALLATIONS: Aeronautical and Ordnance Systems Division, General Electric Co.

COPIES AVAILABLE: No.
PROGRAMMING SERVICE: Not available.
COMPUTING TIME: Not available.
FLOOR AREA: POWER CONSUMPTION: 12 kw.
COOLING: 3000 cu.ft.min. FIRST READY FOR USE:
BEST SUITED FOR: General purpose; ballistic and flight-path studies.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING				
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair	Idle	Total
Hrs/Wk	½	1½	52	10	6	5	75
Percent	0.7	2.0	69.3	13.3	8.0	6.7	100

PERSONNEL: 1 operator, 1 maintenance man, 2 mathematicians, 4 in training as maintenance-operators.

NUMBER BASE: 2
WORD LENGTH: 24 binary digits (instructions 34 binary digits).
NUMBER RANGE: 2^{-32} to 2^{+31} INSTRUCTION TYPE:
NEGATIVE NO. REP.: Twos' complement. SEQUENCE CONTROL: Special drum store.
OPERATIONS: Add, subtract, multiply, divide, extract exponent or integral part of number, transfers of control, synthesize floating-point form, modify instruction, stops.

SPEED:

		Transfer	Addition	Multiplication	Division	All		
Incl. Access	Min.							
	Max.					12 ms		
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic drum (instructions)	Internal	750	36	12 ms		Prellel	6"dia. x 14"long	300rpm
Magnetic drum (numbers)	Internal	640	26	11 ms		Parellel	6"dia x 1¼"long	5400rpm

INPUT/OUTPUT:

Type	Function	Speed
Teletype	In&Out	6⅔ digits per second

TAPE SEARCH:
ARITHMETIC MODE: Parallel. CLOCK FREQ.: 10 kc.
COMPUTING ELEMENT:
COMPONENTS: 3300 tubes.
REMARKS: Floating binary point is used. Separate drums are used to store instructions and numbers. Computer can alter its instructions. In each instruction time (instruction-drum revolution) computer: (1) stores result of previous operation, (2) performs arithmetic of current operation, (3) obtains operands for next instruction.

ONR RELAY COMPUTER
(Office of Naval Research)

BUILT BY:

INSTALLATIONS: Logistics Research Project,
George Washington University, Washington, D.C.
(Owned by the Office of Naval Research.)

COPIES AVAILABLE: No.
PROGRAMMING SERVICE: No.
COMPUTING TIME: Available.
FLOOR AREA: 40 sq. ft. POWER CONSUMPTION: 5 kw.
COOLING: Total 3 hp. FIRST READY FOR USE: 1 May 1951 at G.W.U.
BEST SUITED FOR: General purpose (small input and output).

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk	1.25	1.0	33.5		Test 6.75	0	42½
Percent	2.8	2.4	79.0		15.8	0	100

PERSONNEL: ½ operator, ½ mathematician, 1 maintenance, 1/10 clerical.

NUMBER BASE: 2
WORD LENGTH: 24 binary digits.
NUMBER RANGE: $-(2^{23}-1)$ to $(2^{23}-1)$ INSTRUCTION TYPE: One-address.
NEGATIVE NO. REP.: Ones' complement. SEQUENCE CONTROL: General store.
OPERATIONS: Add, subtract, multiply, divide, extract, unconditional and conditional jumps, selective write.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	136 ms	272 ms	2.5 sec	2.5 sec			
	Max.	272 ms	408 ms	2.5 sec	2.5 sec			
Excl. of Access		136 ms		2.5 sec	2.5 sec			

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time		Mode	Drum Diam., Length or CRT Type	Speed of Motion
				Max.	Min.			
Magnetic Drum	Internal	4094	48	136 ms	68 μs	Parallel	8½x12"	440 rpm

INPUT/OUTPUT:

Type	Function	Speed
Paper tape	Input	150 words/minute
Paper tape	Output	150 words/minute
Typewriter	Output	600 characters/minute

TAPE SEARCH: None.
ARITHMETIC MODE: Parallel. CLOCK FREQ.: 15 kc (magnetic-drum clock)
COMPUTING ELEMENT: Relay.
COMPONENTS: 655 tubes, 332 crystals, 734 relays.
REMARKS: See J. J. Wolf, "The Office of Naval Research Relay Computer," Mathematical Tables and other Aids to Computation, VI, No. 40, pp 207-212 (October 1952).

ORACLE
(Oak Ridge Automatic Computer and Logical Engine)

BUILT BY: Argonne National Laboratory
INSTALLATIONS: Oak Ridge National Laboratory

COPIES AVAILABLE: No.
PROGRAMMING SERVICE: Possibly to government and AEC laboratories.
COMPUTING TIME: Possibly to government and AEC laboratories.
FLOOR AREA: 1500 sq. ft. POWER CONSUMPTION: 50 kw.
COOLING: 5000 cu.ft./min. FIRST READY FOR USE: June 1953.
BEST SUITED FOR: General purpose.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2
WORD LENGTH: 40 binary digits (instructions 20 binary digits).
NUMBER RANGE: -1 to $1-2^{-39}$. INSTRUCTION TYPE: One-address.
NEGATIVE NO. REP.: Twos' complement. SEQUENCE CONTROL: General store.
OPERATIONS: Add, subtract, multiply, divide, several transfers of control, partial substitution into the memory, shifts right and left.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	20 μs	28 μs	500 μs	660 μs			
	Max.	40 μs	48 μs	520 μs	680 μs			
Excl. of Access			8 μs	480 μs	640 μs			

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Electrostatic	Internal	1024	80	40 μs	20 μs	Parallel		
Magnetic Tape	External	unlimited	40			Parallel		75"/sec.

INPUT/OUTPUT:

Type	Function	Speed
Teletype	In-Out	

TAPE SEARCH: Possible in both directions.
ARITHMETIC MODE: Parallel. CLOCK FREQ.:
COMPUTING ELEMENT:
COMPONENTS: 3500 tubes.
REMARKS: The logical design of this computer is modelled on the IAS computer.

ORDVAC
(Ordnance Discrete Variable Automatic Computer)

BUILT BY: University of Illinois

INSTALLATIONS: Aberdeen Proving Ground, Maryland (Owned by U.S. Army Ordnance Corps.)
(Financial contributions to development of ORDVAC were made by Office of Naval Research, U.S. Air Force, and Atomic Energy Commission.)

COPIES AVAILABLE: No.

PROGRAMMING SERVICE:

COMPUTING TIME: Available to groups engaged in National Defense work.

FLOOR AREA: 800 sq. ft. POWER CONSUMPTION: 35 kw.

COOLING: 7½ ton air-conditioner. FIRST READY FOR USE: March 1952 to APG.

BEST SUITED FOR: Scientific computation.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING				
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair	Idle	Total
Hrs/Wk	15.8	8	63.5	5.0	27.2	26.3	145.8
Percent	10.7	5.4	43.5	3.4	19	18	100

PERSONNEL: 10 maintenance men, 21 mathematicians.

NUMBER BASE: 2 (16 externally).

WORD LENGTH: 40 binary digits (instructions 20 binary digits).

NUMBER RANGE: -1 to $1-2^{-39}$. INSTRUCTION TYPE: One-address

NEGATIVE NO. REP.: Twos' complement. SEQUENCE CONTROL: General store.

OPERATIONS: Add, subtract, multiply, divide, absolute value, logical multiply, shift, several transfers of control.

SPEED:

	Transfer	Addition	Multiplication	Division	Shift		
Incl. Access Min.		72 μs	642 μs	772 μs			
Incl. Access Max.		72 μs	822 μs				
Excl. of Access		50 μs			16 μs		

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Electrostatic (Williams tube)	Internal	1024	40	36 μs	18 μs	Parallel	3KP1	

INPUT/OUTPUT:

Type	Function	Speed
Tape Reader	Input	25 characters/sec.
Tape Punch	Output	25 characters/sec.
Card Reader (IBM)	Input	
Card Punch (IBM)	Output	

TAPE SEARCH:

ARITHMETIC MODE: Parallel. CLOCK FREQ.: Asynchronous.

COMPUTING ELEMENT: Eccles-Jordan flip-flop.

COMPONENTS: 2700 tubes.

REMARKS: The logical design of this computer is modeled on the IAS computer. ILLIAC is a very similar computer also built by the University of Illinois.

PERM
(Programmgesteuerte Elektronenrechenmaschine, München)

BUILT BY: Arbeitsgemeinschaft für Elektronische Rechenmaschinen,T.H.,Munich.
INSTALLATIONS: Technische Hochschule, Munich, Germany.

(The Deutsche Forschungsgemeinschaft contributed support to the development of the computer.)

COPIES AVAILABLE: No.
PROGRAMMING SERVICE:
COMPUTING TIME:
FLOOR AREA: Room 800 sq.ft. POWER CONSUMPTION: 7 kw.
COOLING: FIRST READY FOR USE: 1954.
BEST SUITED FOR: General purpose.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING				
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair	Idle	Total
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2 (10 externally).
WORD LENGTH: 49 binary digits (9 for exponent)(instructions 50 binary digits).
NUMBER RANGE: Floating or fixed pt. INSTRUCTION TYPE: One-address.
NEGATIVE NO. REP.: Complement. SEQUENCE CONTROL: General store.
OPERATIONS: Addition, subtraction, multiplication, division.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.							
	Max.							
Excl. of Access			4-8 μs	0.1-1 ms	0.1-1 ms			

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic drum	Internal	8192	200	4 ms	0	Parallel	4" dia. 8" long	250 rps

INPUT/OUTPUT:

Type	Function	Speed
Teletype	In&Out	

TAPE SEARCH: None.
ARITHMETIC MODE: Parallel. CLOCK FREQ.: 250 kc.
COMPUTING ELEMENT: Tubes.
COMPONENTS: 1700 tubes, 2000 crystal rectifiers.
REMARKS:

PTERA

(Postal Telecommunications Electronic Automatic Calculator)

BUILT BY: Central Laboratory, P&TS, the Hague

INSTALLATIONS: Central Laboratory of the Postal and Telecommunications Services, the Hague, the Netherlands

COPIES AVAILABLE: No

PROGRAMMING SERVICE: Not available

COMPUTING TIME: Not available

FLOOR AREA: 6 ft. x 12 ft. POWER CONSUMPTION: 8-9 kw

COOLING: FIRST READY FOR USE: January 1953

BEST SUITED FOR: General purpose, filter and antenna design

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL: Estimated: 1 operator, 1 maintenance man, 3 mathematicians, 3 programmers.

NUMBER BASE: 2 (only 10 externally)

WORD LENGTH: 31 binary digits (instructions 18 binary digits)

NUMBER RANGE: -1 to 1 INSTRUCTION TYPE: One-address

NEGATIVE NO. REP.: Ones' complement SEQUENCE CONTROL: General store

OPERATIONS: Add, subtract, multiply, divide, read, print, stop, conditional skip.

SPEED:

		Transfer	Addition	Multiplication	Division	Conditional skip		
Incl. Access	Min.		50 ms	75 ms		25 ms		
	Max.		50 ms	75 ms		25 ms		
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic drum	Internal	1024	32	25ms	25ms	Serial	8"dia.	2400rpm
	Future:	2048	64				10"long	

INPUT/OUTPUT:

Type	Function	Speed
Punched paper tape	Input	20 decimal digits/sec.
Typewriter	Output	10 decimal digits/sec.

TAPE SEARCH: None

ARITHMETIC MODE: Serial; parallel mult. CLOCK FREQ.: 50 kc

COMPUTING ELEMENT: Kirchoff-adder; multiplicands stored on relays.

COMPONENTS: 650 tubes, about 20 crystals, 120 relays

REMARKS: The successive digits of a word are stored in every 32nd location around the drum so as to permit serial operations as the digits appear. The computer makes very economical use of registers, three 31-digit registers sufficing for instruction register, program counter, multiplicand storage, and double-length accumulator.

R 4 S

BUILT BY: Eidgenossische Technische Hochschule, Zurich.
INSTALLATIONS: Eidg. Techn. Hochschule, Institut für angewandte Mathematik, Zurich, Switzerland.

COPIES AVAILABLE: No.
PROGRAMMING SERVICE: Available.
COMPUTING TIME: Available.
FLOOR AREA: POWER CONSUMPTION:
COOLING: FIRST READY FOR USE: 1955.
BEST SUITED FOR: Partial differential equations.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 10 (2*,4,2,1 representation).
WORD LENGTH: 15 decimal digits (instructions 7 decimal digits).
NUMBER RANGE: $\pm 10^{-99}$ to $\pm 10^{99}$. INSTRUCTION TYPE:
NEGATIVE NO. REP.: Absolute value & sign SEQUENCE CONTROL: General store.
OPERATIONS: Addition, subtraction, multiplication, division.

SPEED:		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.							
	Max.							
Excl. of Access		1/2 ms	5 ms	20 ms	40 ms			

STORAGE: Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic drum	Internal	10,000	200			Ser.par.		

INPUT/OUTPUT:	Type	Function	Speed
	Punched cards	In&Out	8 words per sec.
	Printer	Output	0.5 words per sec.

TAPE SEARCH:
ARITHMETIC MODE: Serio-parallel. CLOCK FREQ.: 30 kc.
COMPUTING ELEMENT: Crystal rectifiers.
COMPONENTS: 1200 tubes, 500 crystals, 200 relays.
REMARKS: This computer uses a floating decimal point. It incorporates automatic checking of all transfer and arithmetic operations.

RAYDAC
(Raytheon Digital Automatic Computer)

BUILT BY: Raytheon Mfg. Co., Waltham, Massachusetts
INSTALLATIONS: Naval Air Missile Test Center
Point Mugu, California
(Contract to build RAYDAC administered by the Special Devices Center of ONR, funded by Bureau of Aeronautics, U.S.Navy.)

COPIES AVAILABLE: Not available.
PROGRAMMING SERVICE: Probably available.
COMPUTING TIME: Probably available.
FLOOR AREA: 200 sq.ft. POWER CONSUMPTION: 28 kw.
COOLING: Liquid Freon cooling used. FIRST READY FOR USE: July 1953.
BEST SUITED FOR: Data reduction and general large-scale computations.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk	Not established.						
Percent							

PERSONNEL: 4 operators, 14 maintenance, 25 mathematicians, 5 clerical, 4 in training as programmers and coders.

NUMBER BASE: 2 (externally 2,8, and 10).
WORD LENGTH: 30 bits (instructions 54 bits).
NUMBER RANGE: -1 to 1. INSTRUCTION TYPE: Four-address.
NEGATIVE NO. REP.: Sign & absolute value. SEQUENCE CONTROL: General store.
OPERATIONS: Addition, subtraction, multiplication, division, shifting, branch orders, automatic normalization, semi-automatic double-precision orders, floating-point orders, tape orders.

SPEED:

		Transfer	Addition	Multiplication	Division	Shift		
Incl. Access	Min.	115 μs	134 μs	296 μs	470 μs	172 μs		
	Max.	975 μs	1280 μs	1440 μs	1620 μs	1035 μs		
Excl. of Access		48 μs	48 μs	210 μs	380 μs	105 μs		

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Acoustic Delay Line	Internal	1152	36	305 μs	19 μs	Serial	305 μs	
Magnetic Tape	External	400,000	6	4 min.	19 μs	Ser-Par		30"/sec

INPUT/OUTPUT:

Type	Function	Speed
Keyboard	Input	14 words/min
Typewriter	Output	5 digits/sec
Magnetic Tape	In-Out	400 words/sec

TAPE SEARCH: Possible in both directions.
ARITHMETIC MODE: Parallel. CLOCK FREQ.: 3.77 mc in memory.
COMPUTING ELEMENT: Flip-flops, diode gating.
COMPONENTS: 5200 tubes, 17 300-crystal rectifiers, 630 relays.
REMARKS: Fully-automatic built-in self-checking on computation, transfer, selection and control. Each word carried a 4-bit check number (weighted sum of bits) which is recalculated and checked after transfers. For arithmetic check, a 5-bit check number is calculated for each operand and for result, and appropriate checks are calculated for these. See MTAC 24, 286-295 (October 1948).

Rechenautomat IPM

BUILT BY: Institut für Praktische Mathematik, Technische Hochschule, Darmstadt
INSTALLATIONS: Technische Hochschule, Darmstadt, Germany.

(The development of the computer has been supported by the Deutsche Forschungsgemeinschaft and ERP Authority.)

COPIES AVAILABLE: No.
PROGRAMMING SERVICE: Available.
COMPUTING TIME: Available.
FLOOR AREA: POWER CONSUMPTION:
COOLING: FIRST READY FOR USE: End 1953.
BEST SUITED FOR: General purpose.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 10 (excess-three code).
WORD LENGTH: 12 decimal digits (instructions equivalent of 5 decimal digits).
NUMBER RANGE: Variable dec. point. INSTRUCTION TYPE: One-address.
NEGATIVE NO. REP.: Complement. SEQUENCE CONTROL: Special drum store.
OPERATIONS: Addition, subtraction, multiplication, division, conditional transfer.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	0.4 ms	0.4 ms	40 ms	40 ms			
	Max.	20 ms	20 ms	60 ms	60 ms			
Excl. of Access		0.4 ms	0.4 ms	6 ms	20 ms			

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic drum	Internal	500	10	20 ms	0	Serial	8"	3000rpm
	Instrs.	500	5	20 ms	0	Serial		

INPUT/OUTPUT:

Type	Function	Speed
Punched tape	Input	200 characters per second
Tape punch	Output	7 characters per second
Typewriter	Output	10 characters per second
Punched cards	In&Out	1 card per second

TAPE SEARCH: None.
ARITHMETIC MODE: Serial. CLOCK FREQ.: 150 kc.
COMPUTING ELEMENT: Germanium diode networks.
COMPONENTS: About 300 tubes, 1000 crystal rectifiers, and 100 relays.
REMARKS: Marginal checking is incorporated in the computer.

BUILT BY: Remington Rand Inc.
INSTALLATIONS: About 40 in use.

COPIES AVAILABLE: For sale or rent.
PROGRAMMING SERVICE: Available at Remington Rand offices.
COMPUTING TIME: Available at Remington Rand offices.
FLOOR AREA: 43.6 sq. ft. POWER CONSUMPTION: 10 kva.
COOLING: 3-ton air cond. FIRST READY FOR USE: December 1951.
BEST SUITED FOR: Punch-card accounting and scientific computing.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk	None	None	29.1	0.4	0.5	10	40
Percent	--	--	72.75	1.0	1.25	25	100

PERSONNEL: ½ operator, 1 maintenance man, ½ programmer. Complete maintenance is provided by Remington Rand.

NUMBER BASE: 10 (represented by none, one, or two out of five pulses; or true decimal).
WORD LENGTH: 10 digits.
NUMBER RANGE: 10 digits. INSTRUCTION TYPE: Prewired on plugboard.
NEGATIVE NO. REP.: By control. SEQUENCE CONTROL: Plugboard.
OPERATIONS: Shifting decimal, alignment, transfer and intermediate functions, addition, subtraction, multiplication, division.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.							
	Max.							
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time		Mode	Drum Diam., Length or CRT Type	Speed of Motion
				Max.	Min.			
Relays	Internal	10 digits				Parallel		

INPUT/OUTPUT:

Type	Function	Speed
Punch cards	In&Out	150 cards per min.

TAPE SEARCH:
ARITHMETIC MODE: Parallel. CLOCK FREQ.:
COMPUTING ELEMENT: 22 ring counters.
COMPONENTS: 1500 tubes, 200 relays.
REMARKS: Forty algebraic program steps can be performed for each card; any number of repetitions of parts of this sequence can be obtained. Storage is checked by returning "echo" pulses to the accumulator and subtracting to obtain zero.

SEAC
(Standards Eastern Automatic Computer)

BUILT BY: Electronic Computer Laboratory, National Bureau of Standards
INSTALLATIONS: National Bureau of Standards, Washington, D. C.
Machines based on SEAC are located at NBS (DYSEAC); AFMTC, Cocoa, Florida (FLAC); and at the University of Michigan (MIDAC).

COPIES AVAILABLE: No.
PROGRAMMING SERVICE: Available through Applied Mathematics Division, NBS.
COMPUTING TIME: Available through Applied Mathematics Division, NBS.
FLOOR AREA: 150 sq. ft. POWER CONSUMPTION: 15 kw.
COOLING: 2000 CFM at 50°F. FIRST READY FOR USE: May, 1950.
BEST SUITED FOR: General computation service and engineering development.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2 internally; 16 externally, allowing decimal input and output.
WORD LENGTH: 44 binary digits and sign.
NUMBER RANGE: -4 to 4. INSTRUCTION TYPE: 4- and 3-address.
NEGATIVE NO. REP.: Abs. value & sign. SEQUENCE CONTROL: General store.
OPERATIONS: Add, subtract, multiply (high-order, low-order, rounded), divide, substitute digits, logical product, conditional jumps, input, output.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.		0.2 ms	2.4 ms	2.4 ms	Speed with e-s memory		
	Max.		1.5 ms	3.6 ms	3.6 ms	including access.		
Excl. of Access			0.05 ms	2.1 ms	2.1 ms			

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Mercury Delay Line	Internal	512	64	384 μs	48 μs	Serial	8 words	
Wms. Electrostatic	Internal	512	45	12 μs	12 μs	Parallel	5UP1, 3KP1	
4 Magnetic Tape Units	External	26000 ea.	1		0.1 sec	Serial	1200' ea.	5 ft/sec.
Raytheon Tape Unit	External	72000 track	4		0.1 sec	Serial	800 ft.	45" /sec.

INPUT/OUTPUT:

Type	Function	Speed
Teletype Printer & Keyboard	In-Out	6 characters/sec.
Punched Teletype Tape	In-Out	6 characters/sec.
Magnetic Wire (Peirce)	In-Out	3500 binary digits/sec.

TAPE SEARCH: Possible in both direction.
ARITHMETIC MODE: Serial. CLOCK FREQ.: 1 megacycle.
COMPUTING ELEMENT: Germanium diode switches, tube amplifiers, and delay lines.
COMPONENTS: 1300 tubes; 15,800 crystal diodes; 10 relays.
REMARKS: Development supported by USAF, Dept. of Defense, NBS. Odd-even memory check built in. For further information, see "The NBSEAC," by S. N. Alexander in the proceedings of the joint AIEE-IRE computer conference, Feb., 1952, pp 84-89, and "Engineering experience with the SEAC," by Ralph J. Slutz, pp. 90-94.

BUILT BY: Experimental Towing Tank, Stevens Institute of Technology
INSTALLATIONS: Experimental Towing Tank, Stevens Institute of Technology, Hoboken, New Jersey

COPIES AVAILABLE: May be available for sale.
PROGRAMMING SERVICE: To be available.
COMPUTING TIME: To be available
FLOOR AREA: 300 sq. ft. POWER CONSUMPTION: 2.5 kw.
COOLING: No additional req. FIRST READY FOR USE: May 1953
BEST SUITED FOR: To be used for hydrodynamic research.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2 (externally 10; 8, 4, 2, 1 code).
WORD LENGTH: 24 binary digits.
NUMBER RANGE: -1 to 1 INSTRUCTION TYPE: Special.
NEGATIVE NO. REP.: Absolute value & sign. SEQUENCE CONTROL: Special store and punched cards.
OPERATIONS: Digital integration, input-output, decimal-binary and binary-decimal conversion. The computer cannot alter its own instructions.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.							
	Max.							
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic Drum	Internal	1600					10"dia.	1800rpm

INPUT/OUTPUT:

Type	Function	Speed
Punched Cards	Input	30 bits/sec.
Typewriter	Output	7⅓ dec. dig./sec.

TAPE SEARCH:
ARITHMETIC MODE: Serial CLOCK FREQ.: 104 kc.
COMPUTING ELEMENT: Integrators and adders.
COMPONENTS: 450 tubes, 3000 crystal rectifiers, 25 relays.
REMARKS: This computer is very similar to MADDIDA. It contains 100 integrators, each with a constant multiplier.

SWAC
(Standards Western Automatic Computer)

BUILT BY: National Bureau of Standards, Los Angeles, California
INSTALLATIONS: Institute for Numerical Analysis, National Bureau of Standards. (Financial support contributed by the Flight Research Laboratory, Wright Air Development Center.)

COPIES AVAILABLE: Not available.
PROGRAMMING SERVICE: Available to government agencies and contractors.
COMPUTING TIME: Available to government agencies and contractors.
FLOOR AREA: 75 sq. ft. POWER CONSUMPTION: 30 kw
COOLING: 4000 cu. ft./min. FIRST READY FOR USE: 1 January 1952.
BEST SUITED FOR: General-purpose; problems with small am't of input & output.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk	10	5	45	5	15	---	80
Percent	13	6	56	6	19	---	100

PERSONNEL: 12 operators, 6 maintenance men, 6 mathematicians, 2 clerks.

NUMBER BASE: 2
WORD LENGTH: 36 binary digits.
NUMBER RANGE: -1 to 1. INSTRUCTION TYPE: Four-address
NEGATIVE NO. REP.: Abs. value and sign. SEQUENCE CONTROL: General store
OPERATIONS: Arithmetic and logical operations, no divide.

SPEED:

		Transfer	Addition	Multiplication	Division	Extract		
Incl. Access	Min.	64 μs	64 μs	384 μs		64 μs		
	Max.	" "	" "	" "		384 μs		
Excl. of Access		" "	" "	" "				

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Electrostatic	Internal	256	37			Parallel	SJPIA	
Magnetic drum (under const.)	"	4096	128	16ms	16ms	Serial	8½"d.x 30"long	3600rpm

INPUT/OUTPUT:

Type	Function	Speed
Typewriter	In&Out	
Paper Tape	In&Out	
Punched Cards	In&Out	

TAPE SEARCH:
ARITHMETIC MODE: Parallel CLOCK FREQ.: 125 kc
COMPUTING ELEMENT: Flip-flop
COMPONENTS: 2300 tubes, 3000 crystals.
REMARKS:

TAC
(Tokyo Automatic Computer)

BUILT BY: Tokyo Shibaura Electric Manufacturing Company
INSTALLATIONS: Department of Electrical Engineering, University of Tokyo (The Japanese Ministry of Education contributed financial support to the development of TAC.)

COPIES AVAILABLE: No.
PROGRAMMING SERVICE:
COMPUTING TIME:
FLOOR AREA: 2300 sq. ft. POWER CONSUMPTION: 7.5 kw.
COOLING: FIRST READY FOR USE: April 1954.
BEST SUITED FOR: General purpose.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2 (10 externally).
WORD LENGTH: 35 bits (instructions 17 bits)
NUMBER RANGE: Variable. INSTRUCTION TYPE: One-address.
NEGATIVE NO. REP.: Complement. SEQUENCE CONTROL: General store.
OPERATIONS: Addition, subtraction, multiplication, division, shift, conditional transfer, input, output.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	432 μs	144 μs	4.8 ms	9.9 ms			
	Max.	576 μs	288 μs	10.4 ms	10.0 ms			
Excl. of Access		432 μs	144 μs	4.8 ms	9.9 ms			

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Electrostatic	Internal	512	8	144μs		Serial	3"	
Magnetic Drum	External	1536	35	30ms		Parellel		

INPUT/OUTPUT:

Type	Function	Speed
Tape Reader	Input	
Typewriter	Output	

TAPE SEARCH:
ARITHMETIC MODE: Serial. CLOCK FREQ.: 250 kc.
COMPUTING ELEMENT:
COMPONENTS: 1200 tubes, 2400 crystal rectifiers, a few relays.
REMARKS: Input and output decimal. Number represented between -1 and 1 with a multiplier of $2^{\pm k}$ where k ranges from 0 to 63.

TC-1
(Telemeter Computer Model #1)

BUILT BY: International Telemeter Corp., Los Angeles, California.
INSTALLATIONS:

COPIES AVAILABLE: Can be made available for sale or for rent.
PROGRAMMING SERVICE:
COMPUTING TIME:
FLOOR AREA: 30 sq. ft. POWER CONSUMPTION: 50 kw.
COOLING: 7½ ton refrigeration. FIRST READY FOR USE: Spring 1955.
BEST SUITED FOR: General scientific computation.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2 (10 or 16 externally).
WORD LENGTH: 40 binary digits (instructions 20 binary digits).
NUMBER RANGE: -1 to $1-2^{-39}$. INSTRUCTION TYPE: One-address
NEGATIVE NO. REP.: Twos' complement SEQUENCE CONTROL: General store.
OPERATIONS: Add, subtract, multiply, divide, transfer, logical decision.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	20 μs	52 μs	710 μs	752 μs			
	Max.	40 μs	72 μs	730 μs	772 μs			
Excl. of Access		20 μs	32 μs	690 μs	732 μs			

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Electrostatic (Williams tube)	Internal	1024	40	40 μs	20 μs	Parallel	3KP1	
Magnetic Drum	External	8192	160	17 ms	80 μs	Serial	8½" dia.	

INPUT/OUTPUT:

Type	Function	Speed
IBM Collator	Input	240 cards/min.
IBM Summary Punch	Output	100 cards/min.
Flexowrtier Tape	Input	10 characters/sec.
Flexowriter Tape	Output	10 characters/sec.

TAPE SEARCH:
ARITHMETIC MODE: Parallel. CLOCK FREQ.: No clock.
COMPUTING ELEMENT:
COMPONENTS: 3500 tubes, no crystals, no relays.
REMARKS: Design of this computer is based on ORDVAC, hence indirectly its logical design is based on the IAS computer. Actual construction has not started yet (April 1953) and is pending completion of contract.

Tokyo Mark I

(Pilot Model of Large Scale Automatic Relay Computer)

BUILT BY: Laboratory of Applied Mathematics, Electrotechnical Laboratory,
INSTALLATIONS: Laboratory of Applied Mathematics. Tokyo, Japan.

COPIES AVAILABLE: Not available
PROGRAMMING SERVICE: Not available
COMPUTING TIME: Not available
FLOOR AREA: 80 sq. ft. POWER CONSUMPTION:
COOLING: None FIRST READY FOR USE: March 1953
BEST SUITED FOR: Constructed primarily as pilot model.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2 (10 externally).
WORD LENGTH: 16 bit
NUMBER RANGE: Variable INSTRUCTION TYPE: One-address
NEGATIVE NO. REP.: Sign bit & abs. val. SEQUENCE CONTROL: Plugboard
OPERATIONS: Add, subtract, multiply, divide, decimal-binary and binary-decimal conversion.

SPEED:		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.							
	Max.		50 ms	200 ms	200 ms			
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time		Mode	Drum Diam., Length or CRT Type	Speed of Motion
				Max.	Min.			
Relay	Internal	6				Parallel		

INPUT/OUTPUT:

Type	Function	Speed
Keyboard	Input	
Display Panel	Output	

TAPE SEARCH:
ARITHMETIC MODE: Parallel CLOCK FREQ.:
COMPUTING ELEMENT: Relays
COMPONENTS: 1500 relays
REMARKS: Range of numbers $2^{-9}-1$ to $1-2^{-9}$ times $2^{\pm k}$ where k varies from 0 to 15. Adder and multiplier-divider are separate units and may operate simultaneously.

Tokyo Mark II
(Large-Scale Automatic Relay Computer)

BUILT BY: Laboratory of Applied Mathematics, Electrotechnical Laboratory,
INSTALLATIONS: Laboratory of Applied Mathematics Tokyo, Japan
(The development of the computer is supported by the Agency of Industrial Science and Technology, Ministry of International Trade and Industry, of the Japanese government.)

COPIES AVAILABLE: Not available.
PROGRAMMING SERVICE:
COMPUTING TIME:
FLOOR AREA: 50 sq. ft. POWER CONSUMPTION:
COOLING: None. FIRST READY FOR USE: March 1954.
BEST SUITED FOR: General purpose.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2 (10 externally). and sign, 7 bits for exponent and sign.
WORD LENGTH: 42 bits (instructions no more than 30 bits). 35 bits for factor/
NUMBER RANGE: Variable. INSTRUCTION TYPE: One-address.
NEGATIVE NO. REP.: Sign bit & abs.val. SEQUENCE CONTROL: Paper-tape (non-alterable).
OPERATIONS: Add, subtract, multiply, divide, decimal-binary and binary-decimal conversion.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.							
	Max.		70 ms	300 ms	300 ms			
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Relay	Internal	1000				Parallel		

INPUT/OUTPUT:

Type	Function	Speed
Tape Reader	Input	
Tape Punch	Output	
Typewriter	Output	

TAPE SEARCH:
ARITHMETIC MODE: Parallel. CLOCK FREQ.: No clock.
COMPUTING ELEMENT: Relays.
COMPONENTS: 50,000 relays.
REMARKS: Numbers range from $2^{-33}-1$ to $1-2^{-33}$ times $2^{\pm k}$ where k varies from 0 to 63. Adder and multiplier-divider are separate and may operate simultaneously. Transfer is always checked by automatic circuits which automatically correct errors within their capacity and otherwise stop computer. Separate 30-hole and 42-hole tape readers are used for instructions and numbers.

BUILT BY: Telecommunications Research Establishment (Radar Res. Est.)
INSTALLATIONS: Telecom. Res. Est., Great Malvern, England (The British Ministry of Supply supported the development of the computer.)

COPIES AVAILABLE: No.
PROGRAMMING SERVICE: Not available.
COMPUTING TIME: Not available.
FLOOR AREA: 14 ft. x 6 ft. POWER CONSUMPTION: 10 kw
COOLING: 2050 cu. ft./min. FIRST READY FOR USE: Summer 1953.
BEST SUITED FOR: General purpose.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2 (10 externally).
WORD LENGTH: 24 binary digits.
NUMBER RANGE: -1 to $1 - 2^{-23}$ INSTRUCTION TYPE: One-address.
NEGATIVE NO. REP.: Twos' complement. SEQUENCE CONTROL: General store.
OPERATIONS: Add, subtract, transfer, shift right, jump, conditional jump, input, stop; and the logical operations "and", "or", "and/or", and "equivalence"; no multiply or divide.

SPEED:		Transfer	Addition	Multiplication	Division	Most others		
Incl. Access	Min.	40 μs	40 μs			40 μs		
	Max.	40 μs	40 μs	About 10ms	(pro-grammed)	40 μs		
Excl. of Access								

STORAGE: Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Electrostatic	Internal	Present 512 Future 1024	24		5 μs	Parallel	VCRX266	
Electrostatic	Internal	1024	24		5 μs	Parallel	VCRX266	
Magnetic drum								
Mode I	External	65,536	24	1¼ sec	10 μs	Parallel	4" dia., 9" long	1500 rpm
Mode II	External	2,048	24	40 ms	10 μs	Parallel		

INPUT/OUTPUT:

Type	Function	Speed
Punched tape (5-hole)	In-out	10 rows/second
Teleprinter		

TAPE SEARCH: None.
ARITHMETIC MODE: Parallel. CLOCK FREQ.: 100 kc
COMPUTING ELEMENT: Tubes.
COMPONENTS: 2000 tubes, 1000 crystals, 25 relays.
REMARKS: This computer uses two wires to transfer each binary digit, one for 0, the other for 1. Similarly each register uses two flip-flops per digit, of which only one must be flipped. With the drum in mode I, the heads, mounted on a bridge, each traverse a 32-revolution helix in 1¼ sec., returning in another (unusable) 1¼ sec. In mode II the heads remain fixed over a 33rd track.

UNIVAC
(Universal Automatic Computer)

BUILT BY: Eckert-Mauchly Division of Remington Rand, Inc., Phila., Pa.

INSTALLATIONS: #1 Bureau of the Census, Commerce Dept., Suitland, Maryland.
#2 Office of the Air Comptroller, USAF, Washington, D.C.
#3 Army Map Service, U.S. Army, Washington, D.C.
#4 New York University (for Atomic Energy Commission), N.Y., N.Y.
#5 University of California Radiation Laboratory, Livermore, Calif.
#6 David Taylor Model Basin, U.S. Navy Bureau of Ships, Carderock, Md.

COPIES AVAILABLE: For sale.

PROGRAMMING SERVICE: Available on #4 & 5 to AEC contractors et al., on #6 to BuShips activities.

COMPUTING TIME: Available on #3 on military priority and as above.

FLOOR AREA: About 25'x50'. POWER CONSUMPTION: 120 kva.

COOLING: 35 tons/26,000cfm. FIRST READY FOR USE: 3/51, '52, 1/53, 5/53, 4/53, 7/53.

BEST SUITED FOR: General-purpose computing with large amounts of input and storage.

OPERATING SCHEDULE: of #2/#3/#4

	ENGINEERING		PROBLEM SOLVING			Instruct'n Debugging	Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair			
Hrs/Wk	34/16/24	0	75/110/115	0/0/5	34/10/24	25/-/-		168/136/168
Percent	20/12/14	0	45/81/69	0/0/3	20/7/14	15/-/-		100%

PERSONNEL: On #2/#4/#5/#6: -/10/8/6 operators, 10 to 12/5/8/7 maintenance men, 15/31/20/15 mathematicians, -/5/4/2 clerical, -/15/-/all in training, 4/-/-/- on auxiliary equipment.

NUMBER BASE: 10 (excess-three code), alphameric (6-bit code plus check bit).

WORD LENGTH: 12 characters, including sign (instructions 6 characters).

NUMBER RANGE: $10^{-11}-1$ to $1-10^{-11}$. INSTRUCTION TYPE: One-address (two per word).

NEGATIVE NO. REP.: Magnitude and sign. SEQUENCE CONTROL: General store.

OPERATIONS: Addition, subtraction, multiplication, division, branch orders, input, output, tape orders, logical multiplication, store program-counter contents.

SPEED:

	Transfer	Addition	Multiplication	Division	Comparison		
Incl. Access — Average	404 μs	525 μs	2.15 ms	3.89 ms	365 μs		
Incl. Access — Max.							
Excl. of Access	40.4 μs	285 μs					

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Mercury delay lines	Internal	1000	100	404 μs	40.4 μs	Serial		
10 magnetic tapes	External	96,000 per tape	8	3 min.		Ser-par.	1500 ft per tape	100"/sec

INPUT/OUTPUT:

Type	Function	Speed
Magnetic tapes	In & Out	225 words per second
Typewriter	Output	11 characters per second

TAPE SEARCH: Possible in both directions.

ARITHMETIC MODE: Serial. CLOCK FREQ.: 2.25 mc.

COMPUTING ELEMENT: Flip-flop.

COMPONENTS: 5600 tubes, 18,000 crystal diodes, and 300 relays.

REMARKS: Checking is provided by duplicate arithmetic circuits with automatic comparison of results, and checking for oddness of the number of ones in the code for each character after a transfer of information.

BUILT BY: Nuclear Energy for Propulsion of Aircraft (NEPA) Project
INSTALLATIONS: Oak Ridge National Laboratory
(The U. S. Air Force contributed financially to the development of one computer.)

COPIES AVAILABLE: No.
PROGRAMMING SERVICE:
COMPUTING TIME:
FLOOR AREA: 600 sq. ft. POWER CONSUMPTION: 15 kw.
COOLING: 2500 c.f.m. FIRST READY FOR USE: 1 June 1950.
BEST SUITED FOR: Inversion of matrices; solution of simultaneous linear equations.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING				
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair	Idle	Total
Hrs/Wk	4	4	28	0	4	0	40
Percent	10	10	70	0	10	0	100

PERSONNEL: 2 operators, 1 maintenance man.

NUMBER BASE: 10 (excess-3).
WORD LENGTH: 4 decimal digits (instructions 4 binary digits).
NUMBER RANGE: -1 to 1 INSTRUCTION TYPE: One-address.
NEGATIVE NO. REP.: Nines' complement SEQUENCE CONTROL: Built-in and magnetic tape.
OPERATIONS: Addition, subrraction, multiplication, Gauss-Seidel iterative process.

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	1.5 ms	7 ms	7 ms				
	Max.	1.5 ms						
Excl. of Access			20 μs	320 μs				

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Circulating Magnetic Tape	Internal	350	6	2 s	6 ms	Ser.-Par.	40" long	20"/sec.
Magnetic Tape	External	90,000	5			Ser.-Par.	1200 ft.	20"/sec.

INPUT/OUTPUT:

Type		Speed
Adding Machine	Output	1 word/sec.

TAPE SEARCH: Not possible.
ARITHMETIC MODE: Serio-parallel. CLOCK FREQ.: 50 kc.
COMPUTING ELEMENT: Vacuum diodes.
COMPONENTS: 2200 tubes, 20 crystals, about 50 relays.
REMARKS: Automatic checking includes check for overflow, misoperation of read-in circuits and multiplier, tape synchronization.
See J. J. Stone, "The USAF-Fairchild Specialized Digital Computer," Mathematical Tables and other Aids to Computation, VII, No. 41, pp 35-37, (Jan. 1953).

UTEC
(Model, University of Toronto Electronic Computer)

BUILT BY: Computation Centre, University of Toronto
INSTALLATIONS: Computation Centre, University of Toronto
(The Defense Research Board of Canada contributed financially to the development of the computer.)

COPIES AVAILABLE:
PROGRAMMING SERVICE: No.
COMPUTING TIME: No.
FLOOR AREA: 375 sq. ft. POWER CONSUMPTION: 4 kw.
COOLING: 6 fans. FIRST READY FOR USE: 1952
BEST SUITED FOR: Mathematical problems, limited storage, input and output.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2 (10 externally).
WORD LENGTH: 12 binary digits (instructions 12 binary digits).
NUMBER RANGE: 0 to 2^{24}. INSTRUCTION TYPE:
NEGATIVE NO. REP.: Twos' complement. SEQUENCE CONTROL: General store.
OPERATIONS: Only 8 orders; add, subtract, clear to transfer, critical transfer, input, output, 2 special orders. No multiplication, no division.

SPEED:		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.	100 μs	100 μs	Coded	Coded			
	Max.							
Excl. of Access		50 μs						

STORAGE: Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Electrostatic	Internal	512	12	25 μs		Parallel	3" CRT	

INPUT/OUTPUT:

Type	Function	Speed
Paper Tape Reader	Input	
Paper Tape Punch	Output	
Typewriter	Output	

TAPE SEARCH: Magnetic tape search is possible in both directions.
ARITHMETIC MODE: Parallel. CLOCK FREQ.: 100 kc.
COMPUTING ELEMENT:
COMPONENTS: 400 tubes, 200 crystals, 25 relays.
REMARKS: Computer is completed, but will not be put into operation until FERUT is loaded.

WHIRLWIND I

BUILT BY: M.I.T. Digital Computer Laboratory
INSTALLATIONS: M.I.T. Digital Computer Laboratory
Cambridge, Massachusetts

COPIES AVAILABLE: Not available
PROGRAMMING SERVICE: Not available
COMPUTING TIME: Some time available for academic use by MIT staff and others.
FLOOR AREA: 3300 sq. ft. POWER CONSUMPTION: 60 KW
COOLING: 13000 cu.ft/min. FIRST READY FOR USE: December 1950
BEST SUITED FOR: Real-time control problems, also general-purpose computation.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk	28	60	58	6		16	168
Percent	17	35.5	34.5	3.5		9.5	100

PERSONNEL: 11 operators, 15 maintenance, 45 mathematicians, 13 clerical

NUMBER BASE: 2 (10, 8, or alphameric externally)
WORD LENGTH: 16 bits
NUMBER RANGE: -1 to +1 INSTRUCTION TYPE: One-address
NEGATIVE NO. REP.: Ones' complement SEQUENCE CONTROL: General Store
OPERATIONS: All arithmetic operations, scale factoring, logical orders, versatile input-output orders.

SPEED:

		Transfer to storage	Addition	Multiplication	Division	Transfer Control		
Incl. Access	Min.	86 μs	49 μs	61 μs	100 μs	30 μs		
	Max.	86 μs	49 μs	61 μs	100 μs	30 μs		
Excl. of Access		12 μs	12 μs	24 μs	63 μs	12 μs		

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Vac. Tube Registers	Internal	5		5 μs	5 μs	Parallel		
Keyboards	Internal	27		5 μs	5 μs	"		
Electrostatic Storage	Internal	2048	34	16 μs	16 μs	"	MIT	
Magnetic Drum	External	24576	192	16 ms	64 μs	"	8" dia.	3600 rpm
Magnetic Tape (4)	External	75000 ea.	2 sync.	5 min	3 ms	Ser.-Par	500	100"/sec

INPUT/OUTPUT:

Type	Function	Speed
PE Tape Reader	Input	140 char/sec
Flexowriter Equipment	Output	8-10 char/sec
Magnetic Tape	"	250 char/sec
Oscilloscope & Camera	"	10,000 prints/sec, 150 digits/sec

TAPE SEARCH: Reading, recording, searching all possible under program control.
ARITHMETIC MODE: Parallel CLOCK FREQ.: 2 mc and 1 mc
COMPUTING ELEMENT: Flip-flops
COMPONENTS: 6800 tubes, 22000 crystal rectifiers, 1800 relays.
REMARKS: 12 of the 28 hours of scheduled maintenance represent time allowed for recovery from installation of new terminal equipment. Extra bit in electrostatic storage provides parity check. There are transfer checks, arithmetic overflow alarm, and marginal checking facilities.

WISC
(Wisconsin Integrally Synchronized Computer)

BUILT BY: Electrical Engineering Department, University of Wisconsin
INSTALLATIONS: University of Wisconsin
(Development of the computer was supported in part by the Wisconsin Alumni Research Foundation, the Engineering Experiment Station, and the University of Wisconsin.)

COPIES AVAILABLE:
PROGRAMMING SERVICE: Available to Univ. of Wisconsin and interested concerns.
COMPUTING TIME: Available to Univ. of Wisconsin and interested concerns.
FLOOR AREA: 12 sq. ft. POWER CONSUMPTION: 6.6 kw.
COOLING: FIRST READY FOR USE: 1954.
BEST SUITED FOR: General purpose (small input-output problems).

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL:

NUMBER BASE: 2 (10 externally).
WORD LENGTH: 50 bits.
NUMBER RANGE: 10^{-75} to 10^{75}. INSTRUCTION TYPE: Three-address.
NEGATIVE NO. REP.: Absolute value & sign. SEQUENCE CONTROL: General store.
OPERATIONS: Add, subtract, multiply, divide, compare - all either algebraic or absolute value - transfer, in, out, halt (conditionally or definitely); extract (substitute digits).

SPEED:

		Transfer	Addition	Multiplication	Division			
Incl. Access	Min.							
	Max.	17 ms	17 ms	17 ms	17 ms			
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Magnetic Drum	Internal	1024	32	17ms		Serial	8.5"dia.	3525rpm
Magnetic Drum	Internal	4	4	550μs		Serial	8.5"dia.	3525rpm
Magnetic Drum	Internal	3	3	400μs		Serial	8.5"dia.	3525rpm
(44-bit words)								

INPUT/OUTPUT:

Type	Function	Speed
Flexowriter	In-Out	10 decimal digits/sec.
(6 channel paper tape)		

TAPE SEARCH: None.
ARITHMETIC MODE: Serial. CLOCK FREQ.: 100 kc.
COMPUTING ELEMENT: Vacuum tube.
COMPONENTS: 700 tubes, 60 crystal rectifiers.
REMARKS: Provision made for operation one cycle at a time. The following four procedures are normally carried out at the same time (integral synchronization): (1) locate order N, (2) locate the two operands called for by order N-1, (3) perform operation specified by order N-2, (4) deliver to storage result of order N-3.

Z 4
(Zuse)

BUILT BY: Zuse K.G., Neukirchen (Kreis Hünfeld), Germany
INSTALLATIONS: Eidgenossische Technische Hochschule, Institut für angewandte Mathematik, Zurich, Switzerland

COPIES AVAILABLE: No.
PROGRAMMING SERVICE: Available.
COMPUTING TIME: Available.
FLOOR AREA: 160 sq. ft. POWER CONSUMPTION: 1 kw.
COOLING: None. FIRST READY FOR USE: 1950.
BEST SUITED FOR: Differential equations

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk	2		108	4	6		120
Percent	1.7		90	3.3	5		100

PERSONNEL: 2 operators, 2 maintenance men, and 2 mathematicians (all part time).

NUMBER BASE: 2 (10 externally).
WORD LENGTH: 32 binary digits (instructions 8 binary digits).
NUMBER RANGE: $\pm 2^{-63}$ to $\pm 2^{63}$. INSTRUCTION TYPE:
NEGATIVE NO. REP.: Absolute value & sign SEQUENCE CONTROL: Paper tape.
OPERATIONS: Addition, subtraction, multiplication, division, square root; multiplication by 2, 10, $\frac{1}{2}$, 1/3, 1/5, 1/7, π, $1/\pi$, -1.

SPEED:		Transfer	Addition	Multiplication	Division	Square Root		
Incl. Access	Min.		0.5 sec	1 sec	5 sec	5 sec		
	Max.	0.5 sec	1.0 sec	3 sec	5 sec	5 sec		
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Mechanical store	Internal	64		0.5 s		Parallel		

INPUT/OUTPUT:

Type	Function	Speed
Paper tape	In&Out	30 words per min.
Printer	Output	20 words per min.

TAPE SEARCH: None.
ARITHMETIC MODE: Parallel. CLOCK FREQ.: 20 cycles per sec.
COMPUTING ELEMENT: Relay.
COMPONENTS: 2200 relays.
REMARKS: This computer uses a floating binary point. The exponent is represented by 7 binary digits. See Roger C. Lyndon, "The Zuse Computer," Math. Tables and Other Aids to Computation, no. 20, p. 355 (Oct. 1947).

Z 5
(Zuse)

BUILT BY: Zuse K.G., Neukirchen (Kreis Hünfeld), Germany.
INSTALLATIONS: Leitz GmbH., Wetzlar, Optical Works.

COPIES AVAILABLE: For sale.
PROGRAMMING SERVICE: Not available.
COMPUTING TIME: Not available.
FLOOR AREA: POWER CONSUMPTION: 3 kw.
COOLING: None. FIRST READY FOR USE: June 1953.
BEST SUITED FOR: General purpose; optical computations.

OPERATING SCHEDULE:

	ENGINEERING		PROBLEM SOLVING			Idle	Total
	Sched. Maint.	Eng. Dev.	Error-Free	Erroneous	Repair		
Hrs/Wk							
Percent							

PERSONNEL: 1 operator.

NUMBER BASE: 2
WORD LENGTH: 36 binary digits.
NUMBER RANGE: $\pm 2^{-63}$ to $\pm 2^{63}$. INSTRUCTION TYPE:
NEGATIVE NO. REP.: Complement. SEQUENCE CONTROL: Film tape.
OPERATIONS: Addition, subtraction, multiplication, division, square root.

SPEED:

		Transfer	Addition	Multiplication	Division	Square Root		
Incl. Access	Min.	50 ms						
	Max.	100 ms	100 ms	450 ms	750 ms	750 ms		
Excl. of Access								

STORAGE:

Type	Function	Capacity in Words	No. of CRT Magnetic Tracks, or Acoustic Channels	Access Time Max.	Access Time Min.	Mode	Drum Diam., Length or CRT Type	Speed of Motion
Relay (tentative)	Internal	12		100 ms	50 ms	Parallel		
				Cascade				
				operation				

INPUT/OUTPUT:

Type	Function	Speed
Keyboard	Input	
Tape	Input	200 binary digits per sec.
Typewriter	Output	8 characters per sec.

TAPE SEARCH: Possible in the forward direction.
ARITHMETIC MODE: Parallel. CLOCK FREQ.: None.
COMPUTING ELEMENT: Relay.
COMPONENTS: 2500 relays.
REMARKS: This computer uses a floating binary point. The exponent is represented by 7 binary digits.

INDEX OF COMPUTERS

INDEX OF BUILDERS

GEOGRAPHIC LOCATION OF BUILDERS AND COMPUTERS

(FOREIGN)

GEOGRAPHIC LOCATION OF BUILDERS AND COMPUTERS

(USA)